AMERICAN RAILWAY ENGINEERING ASSOCIATION

GENERAL INDEX

TO THE

PROCEEDINGS

Volume 1 to 16 inclusive

(1900 to 1915)

COMPILED UNDER THE DIRECTION OF THE COMMITTEE ON PUBLICATIONS

PUBLISHED BY

AMERICAN RAILWAY ENGINEERING ASSOCIATION

CHICAGO, ILL.

Copyright, 1917,
By AMERICAN RAILWAY ENGINEERING ASSOCIATION
Chicago, Ill.

FOREWORD

The great mass of material contained in the Proceedings of the American Railway Engineering Association—aggregating nearly twenty thousand pages—has demonstrated the need for a General Index of those volumes.

To make this valuable and practical information more readily available to those who have access to the Proceedings of the Association, this Index has been compiled, in the belief that it will be the means of time-saving and ready reference.

This Index has been arranged in alphabetical order, the detailed references to the Proceedings being grouped under appropriate key-words or subheads; a list of the Standing and Special Committees of the Association and an Author Index are included.

The principal key-words have been subdivided thus, Ballast; —Applying;—Choice;—Cost, etc.

It is the intention to reprint this Index every five years and bring it up to date.

Acknowledgment is made of the valuable assistance rendered in the compilation of this Index by Earl Stimson, H. R. Safford, W. D. Pence, C. P. Howard, A. M. VanAuken and Francis H. McGuigan, Jr.

LIST OF STANDING AND SPECIAL COMMITTEES

Roadway (formerly Graduation)	Committee	I
Ballast (formerly Ballasting)	Committee	II
Ties	Committee	III
Rail	Committee	IV
Track	Committee	V
Buildings	Committee	VI
Wooden Bridges and Trestles (formerly Bridges and Trestles)	Committee	VII
Masonry	Committee	VIII
Signs, Fences and Crossings (formerly Signs, Fences, Crossings and Cattle-Guards)	Committee	IX
Signals and Interlocking (formerly Signaling and Interlocking)	Committee	X
Records and Accounts (formerly Reports, Records and Accounts)	Committee	XI
Rules and Organization (formerly Uniform Rules, Organization, Titles, Code, etc.)	Committee	XII
Water Service	Committee	XIII
Yards and Terminals	Committee	XIV
Iron and Steel Structures (formerly part of Committee on Bridges and Trestles)	Committee	XV
Economics of Railway Location	Committee	XVI
Wood Preservation	Committee	XVII
Electricity	Committee	XVIII
Conservation of Natural Resources	Committee	XIX
Uniform General Contract Forms	Committee	XX
Grading of Lumber (formerly Grading and Inspection of Maintenance of Way Lumber)	Committee	XXI
Brine Drippings from Refrigerator Cars	Special Committee	
Classification of Track	Special Committee	
Standard Specifications for Cement	Special Committee	
Stresses in Railroad Track	Special Committee	

PROCEEDINGS INDEXED IN THIS VOLUME

Vol. I	1900	Vol. IX	1908
Vol. II	1901	Vol. X	1909
Vol. III	1902	Vol. XI	1910
Vol. IV	1903	Vol. XII	1911
Vol. V	1904	Vol. XIII	1912
Vol. VI	1905	Vol. XIV	1913
Vol. VII	1906	Vol. XV	1914
Vol. VIII	1907	Vol. XVI	1915

PRINCIPAL KEY-WORDS

Page numbers under this heading refer to this Index.

	Page
Abutments	9
Accounts	10
Additions and Betterments	10
Alinement	11
Alloys	11
Angle Bars	13
Arches	13
Aspects, Signal	179
Authority for Expenditure	13
Automatic Block Signals	179
Axleloads	14
Baggage Rooms	13
Ballast	15
Bessemer Steel	26
Bibliography 15, 29, 65, 93, 130,	139, 146, 179
Bids	29
Blast Boards	26
Bogs	174
Boiler	27
Bolts, Track	213
Bond	67
Borrow Pit	28
Brick	28
Bridges	28
Brine Drippings	40
Buildings	41
Cables	168
Canting Rail	147
Car	49
Carbon Steel	48
Castings	51
Ceilings	41
Cement	51
Chairs, Cast-iron	148
Charts	53
Circuits, Track	188
Classification	29, 101, 214, 253
Clay Ballast	15
Clearances	54
Clearing	168
Coach Yard	253
Coal	54
Coaling Stations	56
Coal Tar	56
Columns	56
Compression	57
Concrete	57
Conservation	65
Contract	67
Contractor	68
Conventional Signs	70
Conveyors	253
Copper Wire	71
Corrosion	71
Cost Data	16, 71
Counterbalancing	123
Cranes	74, 253
Creosote	74
Cribbing	169
Crossings	78
Crossovers	80
Cross-Section	80
Culverts	242
Curvature	83
Curves	80
Cuts and Fills	101
Cypress Lumber	84
Damages	84
Deck Bridge	225
Deflectometer	85
Depreciation	41
Derails	85
Discipline	68

	Page
Disputes	68
Ditches	167
Drainage	86, 167
Drawbridge	34
Drawings	86
Drop Test	150
Dump Cars	87
Dynamometer	87
Easement	81
Economics	88
Electric	93
Electrical Treatment	96, 233
Electrolysis	97
Elevation	215
Embankment	97
Engine	99
Engine House	42
Estimate	100
Excavation	100
Failures (Rail)	151
Fall and Rise	89
Farm Crossings	79
Fastenings, Track	215
Fence	103
Fillers	215
Fills	98
Fir	105
Fireproofing	105
Flangeway	105
Flood	106
Floors	106
Flow (of Water)	233
Foremen	107
Forms (Concrete)	107
Formulas	107
Foundations	107
Freight	107
Freight Handling	108
Freight Houses	42
Frogs	108
Fuel	109
Gage	109
Girders	110
Grade	111
Grading	98
Grading Lumber	128
Gravel	19
Gravity Yards	253
Grubbing	98, 114
Guard Rail	115
Handcars	115
Haul	115
Heading	227
Highway Crossing	79
Hoops	116
Hump Yards	256
Icing	117
Impact	33
Indications, Signal	183
Industrial Tracks	117
Ingots	117
Inspection	154, 183, 247
Insulation	94
Interlocking	94, 183
Iron	119
Joints, Rail	119
Joints, Rivetted	119
Knots	120
Labor	120
Laying Rail	154
Leads, Switch	121
Length (Rail)	154
Liens	121
Lighting	121
Lime	121
Line	11
Live Load	122
Loading	122
Location	122
Locomotive	122
Loose Rock	123
Lumber	123
Maintenance	20, 44, 171, 218
Manganese	129
Manufacture (Rail)	155
Maps	129
Masonry	130

	Page
Material (Forms)	130
Mill Practice	131
Momentum Grade	112
Mortar	131
Motors	184
Nails	132
Niches	228
Nickel Steel	132
Nutlocks	132
Nuts	132
Oak	132
Ocean Piers	139
Oil	133
Oil Burning	133
Oil Houses	133
Open-Hearth Steel	134
Operation	134
Orders, Train	135
Organization	135
Overhaul	115
Paint	136
Pans, Track	239
Passenger	136
Passenger Stations	137
Passing Sidings	219
Paving	137
Payment	69
Piers	138
Pile Drivers	140
Piles	139
Pine	140
Pipe	141
Plans	142
Plant	142
Platforms	143
Plows	143
Pockets, Roadbed	167, 172
Poles	143
Poling Yards	258
Posts	144
Preservatives	144
Pressure	248
Profiles	145
Prices	70
Priming	236
Proposals	70
Pumping	236
Rail	145
Railways	163
Records	163
Reinforced Concrete	62
Reports	163
Reservoirs	236
Resistance	163
Resources, Natural	65
Rest Houses	46
Retaining Walls	166
Rise and Fall	89
Roadbed	166
Roadway	168
Rock	102
Rolled Steel	36
Roofing	46
Roundhouse	176
Rules	176
Safety	177
Sand	177
Scleroscope	177
Scrapers	173
Screw-Spike	178
Seasoning Timber	249
Secondary Stresses	36
Section (Rail)	157
Section Foremen	216
Semaphore	186
Signals	179
Shear	159
Sheet Piling	178
Shops	47
Shop Work	37
Shovels, Steam	192
Shrinkage	159, 173
Sidetracks	219
Sidings	219
Signs	189
Slides	174
Slopes	174
Smoke Jacks	47

	Page
Snow Fences	190
Snow Plows	190
Snow Sheds	190
Sodding	175
Soft Spots in Roadbed	167, 172
Soils	175, 191
Specifications	191
Speed	191
Spikes	215, 220
Spreader	191
Standpipe	57
Stations	192
Steam	192
Steam Shovel	192
Steel	192
Stock-Guards	192
Stone	23
Storehouse	47
Streets	193
Stresses	36, 38, 221
Stringers	210
Structural Steel	35
Structures	193
Stumps	175
Sub-grade	229
Supervisors	221
Surface	221
Switch	194
Switching	196
Switchstand	195
Symbols	70
Tamping	222
Tangent	197
Tanks	197
Team Tracks	197
Telpherage	198
Temperature	160, 227
Terminals	198
Tests	199
Ties	200
Tie-Plates	200
Tie-Spacing	207
Timber	209
Timber Preservation	211
Time Books	210
Tonnage Rating	161
Tool House	212
Tools	211
Track	212
Track Scales	220
Traffic	223
Train Resistance	224
Trains	222
Transfer Yard	260
Trestles	225
Tunnels	226
Turnouts	229
Turntables	229
Truss	226
Unit Stresses	39
Upsets	40
Valuation	230
Velocity	230
Ventilation (of Tunnels)	229
Vertical Curves	83
Virtual Grades	113
Wagon	230
Warehouses	48
Washouts	231
Watchmen	231
Water Pockets	167
Water Power	231
Waterproofing	241
Water Service	231
Wear	242
Weeds	242
Wells	241
Wharves	139
Wheel	243
Whitewashing	243
Wire	244
Wooden Bridges	40
Wood Preservation	244
Yards	252
Zinc	260

SUBJECT INDEX

Alphabetically Arranged

Roman numerals indicate the volume, Arabic numerals indicate the page number. Thus, V, 56, means Volume five, page 56. XII-(3), means Volume twelve, Part three, etc.

A

Abrasion

(see Rail; Ties.)

Abutments

and retaining walls, X-(2), 1051, 1076, 1317.
cost of, for various heights, XIII, 1140.
—for one, in dollars, of different types, XIII, 1127-1139.
—of additional length of superstructure charged to abutments of various heights, XIII, 1140.
—of floor for, for various heights, XIII, 1140.
costs, neatwork, foundation and embankment separated, XIII, 1128.
cubic yards of masonry in, exclusive of footings and copings, XIII, 1090.
estimates of quantities and cost of different masonry abutments, XIII, 1128.
masonry and concrete, "Wing," "V," "T," "Pocket" and "Type C," XIII, 1086-1149.
moving of, X-(2), 1051, 1076.
plans and formulas for types in use, X-(2), 1051, 1076.
waterproofing, XV, 534.

Acceleration

and retardation curves, III, 25; V, 718; XI-(2), 1316, 1325, 1326; XV-(2), 5.
—formulas, IX, 776; XIV, 603.
—locomotive working, coal consumption 4,000 lbs. per hour at various speeds, XV-(2), 18.
—tables, III, 26; V, 718; IX, 781; XIV-(2), 10, 17; XV-(2), 6, 18, 20.

Acceleration—Continued

distance traveled in accelerating or retarding velocity, with locomotive working full power on various gradients, IX, 781.
on various grades and elements, XV-(2), 18.
train resistance, and resistance to, XV-(2), 18.
velocity attained and time required in passing over fifteen miles, IX, 782-784.

Accounts

additions and betterments, what this should include, V, 236, 319.
bridge estimate form, XI-(2), 1120.
classification of construction and operating expenses, III, 404, 418.
—of material, II, 322.
distribution of labor and material, X-(2), 837, 854.
—of labor, III, 395; X-(2), 845.
—of payroll, III, 394.
expenses, maintenance of way, proposed classification, by Walter G. Berg, V, 305.
ledger, of completed work, IX, 672.
ledger, V, 229, 263, 348, 375; VII, 270, 271, 272, 282, 318; VIII, 111, 114, 118, 126; IX 665, 669, 676, 690; X-(2), 865.
methods of handling material, II, 322.
repairs and improvements, distinction between, and proposed classification of maintenance of way expenses, V, 305.

Acid

(see Concrete; Mill Tests; Steel.)

Additions and Betterments

accounts, what this account should include, V, 236, 319.

Addresses

—Miscellaneous

Howard, James E., XIII, 1020.
McKenna, E. W., II, 217.
Taft, William Howard (President of the United States), XI, 27.
von Schrenk, Dr. Hermann, II, 115; III, 117.

—Presidential

Berg, Walter G., IX, 21.
Churchill, Chas. S., XIV, 42.
Cushing, W. C., XIII, 39.
Fritch, L. C., XII, 12.
Johnston, A. W., IX, 9.
Kelley, Howard G., VII, 9; VIII, 7.
Kittredge, George W., III, 10; IV, 6.
McDonald, Hunter, V, 16; VI, 11.

Addresses—Continued

—Presidential

McNab, William, X, 11; XI, 12.
Storey, W. B., XVI, 41.
Wallace, John F., I, 10; II, 10, 331.
Wendt, Edwin F., XIV, 59; XV, 35, 60.

Aggregates

(see Concrete.)

Agreement

(see Contract.)

Air

(see Yards; Seasoning; Tunnels.)

Alinement (Alignment)

alinement, II, 252.
alterations in, claims for, XVI, 571.
curvature, negative value, discomfort to public, V, 727.
—and alinement, elements of economy, formula (see Economics of Railway Location), III, 17; IX, 608.
—earnings often a controlling element, III, 17.
—(see Economics of Railway Location), V, 705, 718, 723, 727.
—varying with radius, V, 723, 724, 726.
curves, minimum radius, early practice, IV, 9.
—compensation for (see Economics of Railway Location), II, 22; V, 667.
—easement of special (see Economics of Railway Location), II, 22; V, 667.
improvement of grade and alinement, I, 30; II, 20; III, 16, 29 (see Economics of Railway Location).
insurance value, V, 728.
organization for grade and curve improvement work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.
tunnels, ventilation, alinement and ascending grades in same direction as prevailing winds, XV, 391.

Alkaline

(see Concrete.)

Allardyce Process

life of ties treated with, XI-(2), 767; 775; XVI, 882.

Alloys

—Aluminum

influence on Bessemer ingots and rails, XV, 337.
—on segregation, XV, 350.

Alloys—Continued

—Chromium Nickel

comparison with Bessemer, XII-(2), 27.
steel, record of tests of rails containing, XIII, 631.

—Copper

showing effect of one-tenth per cent. admixture of various substances with, X-(1), 147.

—Manganese

specifications for frogs and crossings, X-(1), 408; XI-(2), 936; XII-(1), 403, 410; XIII, 371; XVI, 718, 1140.
use of on Norfolk & Western and Lake Shore & Michigan Southern Railways, XIII-(2), 28; XIII, 632.

—Nickel

steel, I, 128; XIII, 631.
—use of on Pennsylvania System, XII, 27, 28.

—Titanium

alloy, comparative wear, XII, 27; XIII, 630; XVI, 226.
Bessemer, tests of, XII-(2), 399.
diagrams showing influence of, on seven tests ingots, XIV, 247-285.
ferro, results from use of rails of this treatment on various roads, XIII, 630.
influence on Bessemer rails and ingots, XIV, 219.
—on ductility in drop test, XIV, 262.
scleroscope test, XII, 510.
segregation influenced by, in Bessemer ingots, XIV, 246.
use of on Baltimore & Ohio Railroad, XI, 516; XII, 27.

—Zinc

effect on track circuits of metal and treated ties, XIV, 75, 1046.

Alluvium

roadbed pressures allowable, in quicksand, alluvium, etc., removal of, XIII, 391.

Aluminum

wire, table giving load, loading and data of various gages, XII-(1), 214.

Anchor

(see Track.)

Angle Bars
development to meet stresses, XVI-(2), 19.
sizes of holes in, V, 536.
standard punching, IV, 515; VI, 757.
stresses in, XVI-(2), 31.
(see Joints; Track.)

Annealing
punched members, its effect compared with plain punching or punching and reaming, IV, 200.

Anthracene Oil
in ether, XI-(2), 812, 816.

Anti-Creepers
(see Track.)

Apprentices
(see Track.)

Arbitration
(see Contract.)

Arches
method of waterproofing, XV, 532.
(see Concrete.)

Asbestos
(see Roof Covering.)

Ash Pits
(see Buildings.)

Aspects
(see Signals.)

Asphalt
(see Roof Covering.)

Authority for Expenditure
approval form, VII, 272, 286, 290.
estimates of cost and authority for proposed work; outline of scheme and description of forms, VIII, 109, 116, 126; X-(2), 865.
form for, VIII, 118, 120, 128.
how approved on various railroads, VII, 323.
(see Ledger Accounts.)

Automatic Block Signals

(see Signals.)

Axle-loads

in 1900, as affecting weight of rail, II, 189.
proposed cross-section for distributing 60,000-lb., VIII, 56.
rail head, flow under wheel loads, XII-(2), 535.

B

Baggage

—Handling

at stations, XIV, 1090.
by motor trucks, XII-(1), 248.
station baggage rooms, V, 37, 45; VI, 682; XI-(2), 1022.

Ballast

(see also Track.)

—Advantages

and disadvantages of various types of, X-(1), 700, 703; XIII, 607.
cleaning foul ballast, advantages of, XV, 990.
gravel ballast, its advantages and disadvantages, X-(1), 703; XIII, 607.
—comparison with stone ballast, X-(1), 720.
—from lake beach, its faults, I, 107.
—method of testing, XVI, 1008.
—percentage of rock, gravel, sand and dust in output of 35 pits, XIII, 100.
—specifications for, X-(1), 703; XI-(2), 908; XVI, 1008.
—volume of sand and dust, X-(1), 704, 721; XIV, 148.
loss through dirty ballast, XV, 999.
stone ballast, its advantages and disadvantages, X-(1), 701, 720.
trap rock, benefits derived from use, X-(1), 717.

—Applying

arrangements of ballast screen and gang, XV, 993.
comparison of cost of placing and maintaining limestone and trap rock compared, X-(1), 716.
organization of ballast gang, XV, 994.
should ballast cleaning be done by extra gang or section crew? XV, 997.
stone ballast, experimental test of three different sizes, on Baltimore & Potomac Railroad, giving cost of material, placing and maintenance, V, 497.

Ballast—Continued

—Banking

banking at end of ties, XVI, 1162.

—Beach Gravel

gravel from lake beach, its faults, I, 107.

—Bibliography

on ballasting, VIII, 47.

—Burned Shale

burned shale ballast, I, 99.
—cost of, V, 492.
cinder, mine (see burned shale).

—Burnt Clay

coal required to burn, XVI, 1161.
cost of maintaining track with, III, 135, 136; V, 489.
cost of, III, 133; X-(1), 700.
cost of, on 22 roads in 1903, V, 492.
cross-section, XV, 984.
plant for burning, X, 697.
preparation and delivery, X, 697.
quality of clay to produce, III, 129, 136; V, 488.
recommended practice, VII, 85.
specifications for, V, 488; XVI, 1009, 1160.
value and cost, I, 99; 104, 108; V, 488, 492, 493; VI,738; VII, 85; X, 697, 700.

—Cementing Gravel

methods of digging and cost of loading, hauling and placing, X-(1), 695.

—Cementing Stone

under ties, XVI, 1165.

—Characteristics

stone, in use on Big Four Railway, X-(1), 719.

—Chatts

advantages and disadvantages, X, 706.
cross-section for, III, 131; V, 490; VI, 743; VII, 87, 92; VIII, 44; XV, 983.

—Chert

use of, V, 469, 490, 490; VIII, 44; X, 982.

Ballast—Continued

—Choice of

reasons for use of ballast analyzed, materials examined, and advantages enumerated, V, 486.
usually limited, suggestions, XVI, 1006.
what constitutes good ballast, V, 485; X-(1), 700; XIII, 290; XI-(2), 907.

—Cinder

engine, recommended practice, VII, 85.
use of, VIII, 44; XV, 983.

—Clay

(see Burnt Clay.)

—Cleaning

engine repairs, cost of reduced by use of dustless ballast, I, 88.
foul, by means of screens, XV, 989.
—instructions for care and use of screens, XV, 998.
—preferable to raising track, XVI, 1167.
—recommendations, XI-(2), 915, 932; XV, 964, 989; XIV, 163; XVI, 1009, 1163.
—saving due to, XV, 999.

—Coarse Sand

when acceptable as ballast, V, 488.

—Comparison

of cost of placing and maintaining limestone and trap rock, X-(1), 716.
percentage of rock, gravel, sand and dust in output of 35 pits, XIII, 103.
with gravel on Big Four Railway, X-(1), 720.

—Conclusions

of Committee, VI, 736; VII, 88; VIII, 46; IX, 310; X-(1), 707; XI-(2), 915; XII-(1), 343; XIII, 126; XIV, 146; XV, 962.

—Cost

at D. L. & W. R. R. quarry, X-(1), 682.
ballasting with different sizes, P. R. R., XIV, 147.
method of handling material and keeping trace of cost and accounts, I, 89.
of different kinds, V, 493.
(see under name of work or variety of Ballast.)

Ballast—Continued

—Cross-Section

plan of, VI, 739, 742; VII, 87; VIII, 44; IX, 309; XVI, 1013.
rules for, XIII, 66.
standards of various roads and recommended type, XV, 972.

—Crushed Gravel

makes best ballast, XVI, 1159, 1163.
screening, washing and crushing, I, 96; VI, 737; X-(1), 723; XIII, 103.

—Crushed Rock

machinery and equipment of a quarry for producing, X-(1), 678.
weight of, X-(1), 679.

—Deck Bridge

compared with open floor, VIII, 253.
plan, VI, 24, 52; VII, 705, 706; IX, 322, 329.

—Deck Trestle

ballast floors, advantages and disadvantages, IX, 330, 371.
—trestles, cost per foot, II, 139; IX, 321, 371; XVI, 893, 1180.

—Definitions

III, 128; V, 486, 491; VI, 736; VII, 83; X-(1), 678; XI-(2), 340; XIII, 95; XVI, 1006.
what is ballast, II, 60.

—Delivery

and preparation of, X-(1), 678, 681, 685, 695, 697.

—Depth

distribution of pressure at bottom of ballast, and tie-spacing, VII, 103, 105.
for best results, III, 120, 144; V, 485, 487, 506; VIII, 52, 59; XII-(1), 341, 345; XIII, 96, 291; XVI, 1007.
for different loadings, VIII, 59.
necessary for rock ballast, XIII, 113.
recommended in 1861, V, 485.
test to determine, XIV, 145; XVI, 1015.
to insure uniform distribution of load, with typical cross-sections, XVI, 1011.

—Dirt

economical disposition of stone and, XV, 900.
loss through dirty ballast, XV, 999.

—Disintegrated Granite

description, mode of loading, cost of loading and weight, VII, 85.

Ballast—Continued

—Disintegrated Stone

partially disintegrated rock, III, 129.
use of as ballast, III, 131; V, 490; VII, 87, 92; VIII, 44; XV, 983.

—Dusty

cost of engine repairs increased by dusty ballast, I, 88.
dust in ballast, its prevention, I, 90, 91.
economy through keeping ballast clean, XV, 999.
percentage of rock, gravel, sand and dust in output of 35 pits, XIII, 100.
volume of sand and dust, X-(1), 704, 721; XIV, 148.

—Economics

reasons for use of ballast analyzed, materials examined and advantages enumerated, V, 486.
saving due to keeping ballast clean, XV, 999.
saving effected by use of trap rock ballast, X-(1), 716.

—Failure

and causes leading thereto, V, 482.

—Formulas

for determining distribution of pressure at bottom of ballast, VII, 102, 104.
for determining per cent. of ingredients in gravel ballast, XIV, 149.
per cent. of wear of ballast and French co-efficient, XI-(2), 911.

—Functions

purpose of ballast analyzed, V, 485.
what ballast is and its functions, II, 60.

—Gang

(see Applying.)

—Geological Description

of trap rock, X-(1), 712.

—Granite

disintegrated, VII, 84, 85.

—Gravel

cleaning foul, need and methods, XI-(2), 915, 932; XV, 964, 989; XIV, 163.
comparison with stone, X-(1), 720.
cost of, in 1903, V, 492.

Ballast—Continued

—Gravel

cross-section, III, 131, 138; VI, 739, 743; VII, 87, 92; VIII, 44; XV, 978.
from lake beach, its faults, I, 107.
from river beds, III, 140.
its advantages and disadvantages, X-(1), 703.
method of testing, XVI, 1008.
opening a pit, X-(1), 681.
percentage of rock, gravel, sand and dust in output of 35 pits, XIII, 100.
percentage of sand allowable in, I, 96; VI, 737; X-(1), 678, 704, 723; XI-(2), 908; XIV, 149, 151.
photographs of typical samples, XIV, 153.
pit, working methods, X-(1), 695.
plant for washing and screening, X-(1), 685, 690; XIII, 103.
qualities essential for good ballast, III, 129, 138; V, 488; VII, 84; X-(1), 723.
recommended practice, VII, 84.
specifications for, X-(1), 703; XI-(2), 908; XVI, 1008.
test of, XIV, 148, 151.
volume of sand and dust in, X-(1), 704, 721; XIV, 148.
when crushed makes best ballast, XVI, 1159, 1163.

—Gumbo

(see Burnt Clay Ballast.)

—Handling

mechanical devices for, XVI, 1017.
methods of handling and keeping trace of cost and accounts, I, 89.
preparation and delivery of ballast, X-(1), 695, 697.

—History

historical, use of ballast, V, 483; XIII, 95.

—Instructions

regarding ballasting, XIII, 66, 920.

—Kinds

materials used as ballast and methods of preparing, I, 87; III, 128, 133; V, 483; VI, 736.

—Loading

depth of ballast for different loadings, VIII, 59.
depth to insure uniform distribution of load, XVI, 1011.
cementing gravel, X-(1), 681.
experiments on Pennsylvania Railroad, XIII, 95, 114; XIV, 144.

Ballast—Continued

—Loading

formulas for determining distribution of pressure at bottom of ballast, VII, 102, 104.
loading and weight of disintegrated granite, VII, 85.
load per square foot under ties in service, VIII, 54.
preparation and delivery of ballast, X-(1), 678, 681, 695, 697.
proposed cross-section for distributing axle-load, VIII, 56.
roadbed adequate for track superstructure equal to present loading, VIII, 57.

—Machinery

ballast spreader, XVI, 1019.
equipment of a quarry for producing crushed rock ballast, X-(1), 678.
mechanical devices for handling ballast, XVI, 1017.
pneumatic tie tamper, XVI, 1017.
unloading cables, length, size, III, 31, 52; VIII, 304, 347, 348.

—Maintenance

comparison of cost of placing and maintaining limestone and trap compared, X-(1), 716.
cost of maintaining track with burnt clay ballast, I, 99, 104, 108; V, 488, 492, 493; VI, 738; VII, 85; X, 697, 700.
cost of natural stone ballast, placing and maintaining, Baltimore & Potomac Railroad, V, 497.

—Material

enumeration and description, I, 87, 88; III, 128; V, 486.

—Mud

pumping under tie, its causes, VII, 117.

—Need of

universal, V, 482; XIII, 290.

—Oiling

applying to roadbed, I, 91; XIII, 295.

—Photographs

of typical samples of ballast, XIV, 153.

—Plans

ballast sections, VI, 739, 742; VII, 87; VIII, 44; IX, 309; XV, 972; XVI, 1013.

—Plant

for burning burnt clay ballast, X, 697.
for washing and screening, X-(1), 685, 690; XIII, 103.

Ballast—Continued

—Plant

machinery and equipment of a quarry for producing crushed rock ballast, X-(1), 678, 715.
mechanical device for handling, XVI, 1017.

—Preparation

and delivery of ballast, X-(1), 678, 681, 685, 695, 697.
methods, I, 87; III, 128, 133; V, 483; VI, 736.
of roadbed, conditions essential to good results from applying ballast, III, 130.

—Pressure

depth of ballast to insure uniform distribution of load, XVI, 1011.
formula for determining pressure at bottom of ballast, VII, 102, 104.
loading and weight, VII, 85.
load per square foot on ballast under ties in service, VIII, 54.
proposed cross-section for distributing axle-load, VIII, 56, 59.
width of roadbed to furnish base under support, VIII, 57.

—Purpose

functions of ballast, II, 60.
of ballast analyzed, V, 485.

—Quality

method of testing gravel ballast, XIV, 149; XVI, 1008.
of gravel, essential for good ballast, III, 129, 138; V, 488; VII, 84; X-(1), 723.
what constitutes good ballast, V, 485; X-(1), 700; XIII, 290; XI-(2), 907.

—Recommendations

as to different materials for ballast, III, 131, 134; VI, 742; VII, 86, 92.
depth recommended in 1861, V, 485.
for burnt clay ballast, VII, 85.

—Requirements

for a good, III, 129, 138; V, 488; VII, 84; X-(1), 723.
sub-grade requirements, III, 130, 141, 143; XII-(1), 341.
washing gravel, description of plants, X-(1), 685.

—Roadbed

cushion between roadbed and ballast, IX, 606.
(see Cross-Section.)

Ballast—Continued

—Rock

crushed rock ballast, detailed account, X-(1), 680, 682.
economical disposition of stone and dirt, XV, 993.
equipment of a quarry for producing crushed rock ballast, X-(1), 678.
necessary depth with rock ballast, XIII, 113.
partially disintegrated rock, III, 129.
percentage of rock, gravel, sand and dust in output of 35 pits, XIII, 100.
recommendations regarding different materials for ballast, III, 131, 134; VI, 86, 92.
trap rock, geological description, X-(1), 712.

—Sand

coarse, when acceptable as ballast, III, 129; V, 488.
definition of sand, X-(1), 678; XII-(1), 340.
percentage of sand allowable in gravel ballast, I, 96; VI, 737; X-(1), 723; XIII, 103.
sand as ballast, III, 129; V, 488.
screen sizes to separate sand, X-(1), 678, 725.
trains do not pick up sand, X-(1), 728.
use, same as chatts.
volume of sand and dust in gravel ballast, X-(1), 704, 721; XIV, 148, 1080.

—Screening

arrangement of screen and gang, XV, 993.
cleaning foul ballast by means of screens, XV, 989.
instructions for care and use of screens, XV, 998.
preparation and delivery of screened gravel ballast, X, 685.
screen for cleaning ballast, XV, 1000.
screening, washing and crushing gravel for ballast, I, 96; VI, 737; X-(1), 723; XIII, 103.
sizes of screen, X-(1), 678, 725.

—Shells

where available, their value and cost, V, 492; VI, 739.

—Shoulder

cleaning stone ballast by use of screens, XV, 989; XIV, 163.

—Size

discussion of sizes of stone ballast, and varieties, III, 128.
experimental test of three different sizes of stone ballast on Baltimore & Potomac Railroad, giving cost of material, placing and maintenance, V, 497.

Ballast—Continued

—Slag

cost of in 1903, V, 492.
cross-section for, same as for rock.

—Specifications

for burnt clay ballast, V, 488; XVI, 1004, 1160.
for gravel ballast, X-(1), 703; XI-(2), 908; XVI, 1008.
for stone ballast, V, 487, 495; VI, 737; VII, 84; X-(1), 703; XI-(2), 907; XVI, 1007.
for trap rock, XI-(2), 908.

—Spreader

ballast, XVI, 1019.

—Stone

advantages and disadvantages, X-(1), 701, 720.
cementing under ties, XVI, 1165.
characteristics of different in use on Cleveland, Cincinnati, Chicago & St. Louis Railway, X-(1), 719.
cleaning when needed, XVI, 1009.
comparison of cost of placing and maintaining limestone and trap rock ballast, X-(1), 716.
comparison with gravel ballast, X-(1), 720.
cost of cleaning, XV, 965.
cost of in 1903, V, 492.
cross-section for, II, 131, 137; V, 490; VI, 743; VII, 87, 92; VIII, 44; IX, 309; XIV, 168; XV, 961, 972, 993; XVI, 1010, 1161.
depth of, III, 131, 144; VII, 104; VIII, 52; XIII, 97, 113; XIV, 144.
detailed account of crushed rock ballast, X-(1), 680, 682.
discussion of sizes and varieties, III, 128.
economical disposition of stone and dirt, XV, 993.
equipment of quarry producing crushed rock ballast, X-(1), 678.
experimental test of three different sizes of stone ballast on Baltimore & Potomac Railroad, giving cost of material, placing and maintenance, V, 497.
practice of railroads using stone as ballast, XI-(2), 917.
preparation and delivery of crushed rock ballast, X-(1), 678.
sizes of, I, 99; V, 494, 496, 502; XI-(2), 917, 931; XIV, 147.
specifications for, V, 487, 495; VI, 737; VII, 84; XVI, 1007; X-(1), 703; XI-(2), 907; XVI, 1007.
tests of for ballast, X-(1), 708.
weight of crushed rock ballast, X-(1), 679.

Ballast—Continued

—Stresses
distribution of pressure, stresses existing in track superstructure, and rational design based thereon, VIII, 52.
experiments on Pennsylvania Railroad, XIII, 95, 114; XIV, 144.

—Sub-grade
cross-section, or sub-ballast, XV, 961, 972, 988; XVI, 1011, 1161, 1163.

—Tamping
how far one-sided can extend, VII, 120.
pneumatic tamper, XVI, 1017.
tamping, pounding and wear affect ballast, VII, 113.

—Tests
experiments on Pennsylvania Lines, XIII, 95, 114; XIV, 144.
of gravel ballast, XIV, 148, 151.
of three different sizes on Baltimore & Potomac Railroad, V, 497.
physical of stone ballast, X-(1), 708; XI-(2), 910; XIII, 97, 111; XVI, 1007.
proposed, to determine proper depth of ballast, XIV, 145; XVI, 1015.

—Tie Spacing
best adapted for, VII, 103, 105.
for 16 ft. 6 in., 22 ft., and 33 ft. switches, XVI, 728.
standard of Lake Shore & Michigan Southern Railway, XIII, 320.

—Tile Drains
under ballast, how placed, XVI, 1167.

—Top
sub- and top-ballast, XV, 961, 972, 988; XVI, 1011, 1161, 1163.

—Track
below high water, ballast for, X-(2), 921, 1105; XVI, 573.
what constitutes ballasted track, II, 60.

—Trap Rock
benefits derived from use, X-(1), 717.
compared with limestone ballast, X-(1), 716.
geological description, X-(1), 712.
possible changes in roadbed sections due to, X-(1), 717.
specifications for, XI-(2), 908.

—Trestles
(see Deck Trestles.)

Ballast—Continued

—Unloading

cables, III, 31, 52; VIII, 304, 347, 348.
(see also Hauling; Machinery.)

—Use

practice of railroads using stone as ballast, XI-(2), 917.
purpose of ballast analyzed, V, 485.
what is ballast and its functions, II, 60.

—Value

of burnt clay ballast, I, 99, 104, 108; V, 488, 492, 493; VI, 738; VII, 85; X, 697, 700.
of shells, where available, as ballast, and cost, V, 492; VI, 739.
reasons for use of ballast analyzed, materials examined and advantages enumerated, V, 486.

—Water Pockets

caused in soft roadbed when ballast is insufficient, VII, 106.
in track, cause and cure, VIII, 541.

—Wear

affect ballast by tamping and pounding, VII, 113.
how it causes deterioration, VII, 115.
per cent. of French co-efficient, XI-(2), 911.

—Weight

of crushed rock ballast, X-(1), 679.
of disintegrated granite, VII, 85.

Barium Hydrate

and soda ash, comparative value as reagents, VIII, 614.
for treating engine water, merits and disadvantages, VII, 678; VIII, 614, 622.

Bars

(see Bridge Upsets; Concrete; Steel, etc.)

Battens

specifications for Douglas fir, XIII, 564.
—for cypress, XIII, 883.

Beams

formulas for determining the strength of concrete beams, V, 624, 633, 635.
(see Bridges; Concrete; Floor Beams.)

Bearing

—Power of Piles
bearing power of piles, XI-(1), 213, 215, 217.

—Soils
classifications of, XVI, 579, 1074, 1081.
for bearing power of soils composing sub-grade of railroad track. XIII, 1153.
soil tests, XI-(1), 219.

Beaumont Oil
life of, XI-(2), 770, 772.

Beech
weight of mixed beech ties in lbs. per cu. ft., at time of treatment, XIII, 869.

Belgian Diagram
of train movements applied to Camden Station, XIV, 914.

Bending Tests
(see Rail.)

Berme
for wasting, VI, 142, 172; XVI, 567.

Berths

—Coal Piers
general features applicable to, V, 139.

Bessemer Process
(see Rail.)

Bethel Process
life of, XVI, 879.

Bids
(see Contract; Proposals.)

Blast Boards
and smoke shields for protecting concrete against locomotive exhaust, XV, 428, 434.

Block Signal
(see Signals.)

Blooms
(see Ingot; Rail.)

Bogs
(see Roadway.)

Boiler

—Compounds
an account of those in use, with method of using, XVI, 86.

—Corrosion
treatment of water for removing harmful ingredients, V, 588; IX, 133.
where treated water was used, trouble, investigation of same, remedy applied and result, XIII, 420.

—Economy
most economical boiler for steam pumping plant, X-(1), 740.

—Foaming
a rating as to incrusting and foaming ingredients, IX, 134.
and scaling in locomotive boilers, use of compounds and mechanical agents to prevent and counteract, XVI, 686.
in boiler using treated water, VI, 599.
or priming, VIII, 615, 621; XVI, 679.
reduced by treating water, VII, 668.

—Life
increased and repairs reduced by use of softened water, V, 591, 592; VI, 603; XV, 693.

—Pressure
diagram of ratio of mean boiler pressure to effective pressure, XI-(2), 1323.

—Scale
an investigation into efficiency of steam pumps, text, diagrams tables, X-(1), 781.
corrosive and scaling matter in boiler water, minimum amount which will justify treatment, rule and formulas, VIII, 610.
cost of removing, II, 230.
its effect on steaming capacity of a boiler, a Wisconsin experiment out of the ordinary, II, 229.
loss in heat transmission due to boiler scale and its relation to scale thickness, IX, 135.
transmission of heat through scale covered boiler tubes, VIII, 144.

—Tubes
diagram showing loss of heat through scaled boiler tubes, VIII, 150.
impurities found in boiler water, scale forming, IV, 587; V, 587.

Boiler—Continued

—Water

(see Water.)

Bolts

(see Track.)

Bond

(see Contract.)

Borrow Pit

excavation, borrow pits, IV, 25; XVI, 568.
land for, purchased at whose expense, IV, 25, 34, 99.
(see Roadway.)

Braid

(see Electric.)

Branding

(see Rail.)

Brick

considerations as to use of, II, 70.
essential qualities of good, II, 70.
for tunnel lining, XI-(2), 1067, 1086; XVI, 573.

Bridges

—Anchoring

protecting ends of bridges and trestles, X-(2), 921; XVI, 573, 1080.
track anchored on bridges subject to overflow, X-(2), 921, 1105; XVI, 573.

—Balanced Locomotives (Impact for)

effect of position of counterbalance on impact on bridges, XV, 34.
vibration of bridges under impact, time of, XII-(2), 27.

—Ballast Deck

compared with open floor, the loads, strains and costs of trestles of steel and wood and spans, VIII, 253.
cost per linear foot of creosoted ballasted trestle, built in 1899, on Santa Fe Railway, II, 139.
plan of ballasted deck wooden trestle, VI, 24, 52; VII, 705; IX, 322.
strains in ballast deck spans by different formulas, IX, 281, 283.

Bridges—Continued

—Bibliography
pile driving, X-(1), 579.
unit strains, IV, 227.
water jet, XII, 282.
wooden bridges and trestles, VI, 36.

—Bids for
points to be specifically determined by buyers when soliciting, XI-(1), 123.
recommended practice in inviting, VI, 198; VII, 184.

—Blast Boards
and smoke shields for protecting concrete against locomotive exhaust, XV, 428, 434.

—Capacity
classification as to safe carrying capacity, IX, 218, 286.

—Castings
specifications for cast-iron and steel, and analytically compared, VI, 269.

—Classification
a study of need of classifying old bridges and suggested method, VIII, 361.
for operating purposes, IX, 219.

—Clearances
on through bridges, VII, 185; XI-(1), 117; XV, 495; XVI, 675, 1108.

—Columns
study of built-up, XIII, 96; XVI, 636, 649.
tests of by Bureau of Standards, XV, 435, 1046; XVI, 636, 649.

—Concrete
encasement as a protection of structural steel, its effectiveness, method of applying and cost, XV, 426.
relative desirability of reinforced concrete versus steel construction for bridges, XI-(1), 128.

—Contracts
bridge fabricating and erecting by, III, 221.

—Conventional Signs
symbols for maps (see Conventional Signs.)

Bridges—Continued

—Corrosion

protection from, rules, X-(2), 1146.

—Cost

and authority for proposed work, VIII, 109, 116, 126; X-(2), 865.
bridge estimate form, XI-(2), 1120.
method of keeping record of construction, repairs and renewals, III, 364.

—Critical Speed

impact, effect on of speed in application of load, XII-(3), 399.
table showing calculated and observed in impact tests, XII-(3), 136.

—Definitions

wooden bridges and trestles, V, 730; VI, 35; VII, 683; VIII, 397; X-(1), 565; XI-(1), 175. (see Timber, Standard Names.) XV, 404.

—Deflection

bending moments in members of transverse frame due to deflections of floor beams, XV, 485.
deflectometer records taken in impact tests, reproduction, XII-(3), 203, et seq.
deflectometer and instrument for measuring effect on bridge under moving loads, instrument and working described, IX, 222, 227; XII-(3), 16.
impact, maximum percentages plate girder deflections, XII-(3), 283.

—Design

decks, distance between (see Plans of Trestles), II, 139.
effect of differences in impact on stringers and floor beams due to, XII-(3), 36.
effect on impact of design, position of counterbalance, rough track, speed of application of load, and flat wheels on cars, XII-(3), 34.
elevating for curves, method, II, 137; VI, 27.
greatest bending moment produced by Cooper's E-40 loading, diagrams, plates and formulas, XII-(3), 308.
hip vertical in riveted truss, unequal stresses found in, XII-(3), 53.
packing (see Metal Details, Plans of Trestles, and Spools or Separators), II, 140; VI, 51; VII, 684, 691, 693; VIII, 447.

Bridges—Continued

—Design

piles, etc., number per bent (see Plans of Trestles), III, 289, 297; V, 747; VI, 26, 45, 50.

specifications for general features, loads, unit strains, proportion of parts and details, VI, 218; VII, 189; XI-(1), 115, 160.

—Details

floor beams, stresses in bridges due to deformation of chords, XV, 486.

floor beams in pin-connected and riveted trusses, lateral bending in, XII-(3), 53.

spacing stiffeners of plate girders, VII, 211.

stresses in floor beams, hip verticals and stringers, XII-(3), 285.

stresses in a horizontal plane due to longitudinal deformation of chords, especially stresses in floor beams and connections, XV, 486.

who should make plans and details for bridge work, II, 222.

—Erection

of bridges by contract, IV, 221.

specifications for erection of steam railroad bridges, XI-(1), 130.

specifications for the erection of steel railway bridges, X-(1), 130; XII-(3), 302, 306, 318; XIV, 83, 935.

—Draw Spans

(see Movable Bridges.)

—Extensometers

impact tests with, and results compared with various formulas, VI, 255.

—Eye-bars

unequal pull of eye-bars found during tests on impact, XII-(3), 52.

—Fabrication

(see Shop Work.)

—Fire Protection

plan for fire protection of wooden bridges, XIV, 694.

—Floor Beams

design, effect of difference in impact on stringers and floor beams, due to, XII-(2), 36.

in pin-connected and riveted trusses, lateral bending in, XII-(3), 53.

stresses in floor beams due to deformation of chords, XV, 486.

Bridges—Continued

—Girders

spacing stiffeners of, VII, 211.
spans, maximum impact percentages, XII-(3), 31.

—Guard Rails

description and photographs showing results of tests on Michigan Central in 1892, on the value of guard rails on bridges, XIV, 684.
extension beyond ends of bridges, XIV, 652, 678; XV, 403, 1036.
faced with iron, II, 140.
inner, III, 298; VI, 44; XIV, 652; XV, 402.
plans showing practice in use of on bridges, XIV, 694.

—Historial

account of the development of metal bridge building in America, XI-(1), 139.
piles, X-(1), 566.
the development of bridge specifications, VI, 199.

—Impact

and secondary stresses, XVI, 667, 1098.
dynamic loads on railroad bridges and the strains caused thereby produced, IV, 232.
effect of difference in impact on stringers and floor beams due to, XII-(2), 36.
flat wheels under cars and effect on impact on structures, XII-(3), 38.
locomotives, effect of position of counterbalance on impact or bridges, XV-(3), 34.
truss girder spans, maximum impact percentages, XII-(3), 31.
truss spans, maximum impact percentages for, XII-(3), 30.
vibration of bridges under impact, XII-(3), 27.
(see Working Unit Stresses.)

—Impact Tests

by deflectometer, data for bridges tested, XII-(3), 61, 63, 64, 65, 66, 67, 69, 70.
centrifugal force of engines used in impact tests at sixty miles per hour, XII-(3), 135.
counterbalance of engine, effect of position on impact on bridge structure, XII-(3), 34, 291.
deflectometer records taken in impact tests, XII-(3), 185, 203.
description of deflectometer, XII-(3), 16, 24, 43, 61.
detailed results of tests and discussion, XII-(3), 24, 40.

Bridges—Continued

—Impact Tests
instrument for measuring effect on bridges under moving train, IX, 222; XI-(3), 16.
secondary stresses obtained during impact tests, XII-(3), 52; XIII, 88.
stress diagrams of bridges tested in impact tests, XII-(3), 141.
tabulation of impact tests on bridges, IX, 229-234.
test trains used and method of conducting impact tests, XII-(3), 21.
tests on bridges with extensometer, VI, 255.
tests made in 1906, X-(2), 1144; in 1907, XII-(3), 61.
unequal stresses on different sizes of built-up chords found during impact tests, XII-(3), 52.
with deflectometer, IX, 222; X-(2), 1143, 1161; XI-(1), 168; XII-(3), 15.

—Inspection
books and forms for track foremen, X-(2), 865.
discussion of form needed for reporting bridge inspection, V, 264; VI, 631.
forms for reporting, V, 232, 235, 266, 268, 272, 273, 348.
inspection reports and records, IX, 213; XI-(1), 126.
inspection and testing at mills, IV, 133; VI, 232; VII, 199.
instructions for inspection of erection of bridges, XIV, 90, 1054.
regular and special inspection of steel bridges, extent and why, IX, 213.
rules for inspection of bridge fabrication, XIII, 87, 1050.
structural steel at mill, of fabrication and erection of steel bridges, instructions to inspectors, XIV, 83, 1048.

—Instructions
bridge foreman's reports, V, 40, 247, 251.

—Interlocking
protection of drawbridges, X-(1), 81, 145.

—Life
of trestles, IX, 372; XVI, 892.

—Loads
a system for uniform live load for railroad bridges, VII, 211.
bridge loading, XII-(3), 317.
by locomotives in service in 1904, VI, 245.
engine loads on turntables, XVI, 664, 1094.
how to treat the dynamic load on railroad bridges, IV, 232.
per foot of track of cars and trains, VI, 241.

Bridges—Continued

—Loads

specifications for, VI, 218.
specifications for dead and moving, VII, 185, 216, 218.
study of train and locomotive, for use in designing bridges, IV, 240; VI, 245.

—Locomotives

axleloads of locomotives in service in 1904, VI, 245.
Cooper's E-40, greatest bending moment produced by (W. H. Schuerman), XII-(3), 308.
counterbalance of engine, effect of position on impact on bridge structure, XII-(3), 34, 291.
study of train and locomotive loads for use in designing bridges, IV, 240; VI, 245.
(see Impact.).

—Maintenance

cost of wooden bridges and trestles, II, 136, 137, 169.
including protection from corrosion, X-(2), 1146.
of bridges, X-(2), 1146.
of existing metal bridges, VIII, 369.
under traffic, XVI, 630.

—Mill Practice

at shops, IV, 137; VI, 236; VII, 203.
inspecting and testing at mill, IV, 133; VI, 232; VII, 199, 203.
inspection of structural steel at mill, XIV, 83, 1048.

—Mitred Joints

mitred rail for drawbridges, XVI, 1050.

—Movable Bridges

interlocking protection, X-(1), 81, 145.
locking arrangement for, X-(1), 82.
locking for, X-(1), 145.
protection of traffic at, XV, 492, 1050; XVI, 1098.
rail-end connection for, XVI-(2), 254.
signals for, X-(1), 82.

—Numbering

mileage method recommended, III, 363.
of bridges and trestles, II, 137.

Bridges—Continued

—Open-Hearth Steel

advantages of for structural work, IV, 143.
developments in production of, IV, 187.
for structural work, IV, 143.

—Overload

(see Capacity.)

—Paint

methods of United States and Canada, XVI, 614, 618.
new fabricated steel, field coat, XVI, 624.
painting steel railway bridges in shop, VI, 236; VII, 203.
procuring and selecting suitable paints for steel structures, X-(2), 1148; XIV, 421; XV, 412; XVI, 605.
protection of iron and steel structures from corrosion, XV, 618.
protection of iron and steel structures against corrosion, pigments, preservative coatings and concrete encasement, XV, 412, 1045; XVI, 605.
specifications for shop painting of structural steel, IV, 136; VI, 236; VII, 203.
tests made on Havre de Grace bridge with preservative coatings, XV, 415; XVI, 610.

—Physical Requirements

comparison of requirements of forty specifications for structural steel, II, 142.
elastic limit in structural steel and method of taking, IV, 266, 276.
elastic strength requirement for steel, XVI, 668, 1107.
of steel on various bridges, IV, 163.
references for physical requirements of structural steel, III, 237.

—Plans

and details for bridge work, III, 222.
and specifications for bridges, III, 221.

—Protecting

ends of trestles and bridges, X-(2), 921; XVI, 573, 1081.
track anchored on bridges subject to overflow, X-(2), 921, 1105; XVI, 573.

—Records

bridge department office records, record book and blank forms for reports, V, 229-242, 275, 280.
bridge department tool report, V, 258.
bridge foreman's time book, II, 316.

Bridges—Continued

—Records
bridge foreman's diary, V, 231, 251, 255.
bridge foreman's daily report, V, 247.
bridge foreman's material report, V, 249, 250.
bridges, numbering of, III, 363.
estimate form for bridges, trestles and culverts, XI-(2), 1121; XII-(3), 415, 418, 420.
for bridge department, forms, obtaining data, and recording and filing, III, 361, 369.
form for bridge record, III, 362, 396; V, 276, 280, 364, 366; VII, 290, 293-299.
forms for reporting bridge inspection, V, 232-235, 268-273, 348.
of bridges and culverts, VII, 273, 291.
what they should contain, III, 361.

—Replacement
determining need for replacement of different types of construction, IX, 235.

—Reports
inspection reports and records, IX, 213; XI-(1), 126.
(see Records.)

—Riveting
European experiments on riveted joints, VI, 421.
experiments to determine effect of reaming and planing, IV, 218.
increased diameter of rivet in finished work where assembled work is reamed or drilled, IV, 217.
riveted joints, tests of, VI, 272, 278, 284, 374, 395, 401, 406.
sheared edges and rivet holes, IV, 218.

—Rolled Steel
proposed specifications for rolled steel, 1901, II, 142, 173, 174; III, 228.
specifications for material, rolled structural steel, IV, 130; VI, 228; VII, 195.
tensile strength of rolled structural steel, IV, 139.

—Seats
use of concrete bridge seats, VI, 703.

—Secondary Stresses
calculation of, theory, XV, 448.
committee study and report of bending and other methods of calculating, XV, 437, 1046; XVI, 667, 1098.
floor beams in pin-connected and riveted trusses, lateral bending in, XII-(3), 53.

Bridges—Continued

—Secondary Stresses
impact and secondary stresses, XVI, 667, 1098.
stresses in floor beams due to deformation of chords, XV, 486.
unequal pull of eye-bars, XII-(3), 52.
unequal stresses on different sides found in built-up chords during impact tests, XII-(3), 52; XIII, 88.
unequal stresses found in posts in pin-connected truss, XII-(3), 53.

—Shear
stress in webs, formula for, VII, 211.

—Shop Work
annealing punched members, IV, 200.
inspecting and testing at shops, IV, 137; VI, 236; VII, 203.
inspecting and testing at mills and shops, IV, 133, 137; VI, 232, 236; VII, 199, 203.
material and workmanship for steel railway bridges, VI, 228; VII, 195.
planing sheared edges in structural steel, IV, 218, 268.
planing and reaming steel railway bridges, specifications, VI, 235.
practice of railroads in 1902 as to punching and reaming structural steel, IV, 215.
punching and reaming experiments, VI, 425.
punching and reaming structural steel, IV, 196.
specifications for design and manufacture of bridges, IV, 130, 141, 143, 253; VI, 218, 447; VII, 185, 218; VIII, 353; XI-(1), 117, 160.
specifications for shop painting structural steel, IV, 136; VI, 236; VII, 203.

—Signals
(see Signals.)

—Special Metals
special metals, VI, 231; VII, 198.

—Specifications
bridge specification loading, XV-(2), 237.
development of bridge specifications, historical, VI, 199.
—of metal bridge building in America, XI-(1), 139.
for design and manufacture of bridges, IV, 130, 141, 143, 253; VI, 218, 447; VII, 185, 218; VIII, 353; XI-(1), 128.
for erection of steel railway bridges, XI-(1), 130; XII-(3), 302, 306, 318; XIV, 83, 935.
for loads, VI, 218; VII, 185, 216, 218.

Bridges—Continued

—Specifications

for planing and reaming, VI, 235.
for material and workmanship for steel structures, IV, 130, 141, 143, 253; VI, 218, 447; VII, 185, 218; VIII, 353; XI-(1), 115, 117, 160.
impact, IV, 242, 245.
shop painting, IV, 136; VI, 236; VII, 203.
unit strains, IV, 240.

—Stresses

axial stress in different elements of a member, XV, 490.
bending moments in members of a transverse frame due to deflection of floor beams, XV, 485.
bibliography on unit strains, IV, 227.
due to vibration of individual members, XV, 491.
impact, in floor beams, hip verticals, and stringers, XII-(3), 285.
overstraining members and resultant effect, IV, 233.
safe unit stresses in different timbers, IX, 347, 348.
under dynamic loads in bridges and provision therefor, IV, 232.
unit strains of compression members, IV, 236.
unit, in structural steel, report and discussion, IV, 137.
used in various specifications, IV, 240.
specifications for unit strains, IV, 240.
—schedule of unit strains, rolled structural steel, IV, 137; VI, 220; VII, 187.
values in determining secondary stresses, XV, 474-484.

—Stringers

effect of differences in impact on stringers and floor beams due to design, XII-(3), 60.
impact stresses in stringers, XII-(3), 285.

—Structural Steel

advantages of open-hearth, IV, 143.
grade or grades preferable for bridge work, IV, 139, 145, 158.
instructions for mill inspection, XIV, 86, 1047.
material for steel railway bridges, VI, 228; VII, 195.
notes on strength in (A. W. Buel), VIII, 353.
open-hearth, IV, 143.
physical requirements, III, 234, 236.
specifications, III, 237.

—Supervisors

rules governing, VIII, 26; XI-(1), 39; XIV, 65.

Bridges—Continued

—Tests

at mills, IV, 133; VI, 232; VII, 199.
at shops, IV, 137; VI, 236; VII, 203.
column, by Bureau of Standards, XV, 435, 1046; XVI, 636, 649.
deflectometer, XII-(3), 203.
elastic limit, and method of taking, IV, 266, 276.
European, VI, 421.
full-sized, VI, 237; VII, 204.
impact, XII-(3), 21.
on compression members, IV, 236.
on riveted joints, VI, 272.
punching and reaming experiments, VI, 425.

—Timber

dead, IX, 318, 362.
per cent. of heart (see Sap Edges and Specifications for Timber).
piles, knots, X-(1), 542.
—ring shakes, X-(1), 542.
safe unit strains for, VII, 694.
specifications for Southern pine, X, 180; XII-(3), 586.
standard names for red and white oak used for construction purposes, XII-(3), 603.
tests of effect of steaming and preservatives on strength of, VIII, 432.
tests of strength and effect of knots, VIII, 423, 429.
unit stresses for structural, X-(1), 564.
(see Wooden Bridges.)

—Trainload

per foot of track of various cars, VI, 242.
(see Trainload.)

—Trestles

(see Trestles.)

—Turntables

design, length and operation, XVI, 655, 664, 1094.
engine loads on, XVI, 664, 1094.
requirements, VI, 684, 691; XI-(2), 1024; XVI, 740.
tracks, how laid, XVI, 741.

—Unit Stresses

bibliography, IV, 227.
in compression members, tests and formulas, IV, 236.
tables, showing different unit strains and methods of use, IV, 240.
unit strains, V, 195, 279.

Bridges—Continued

—Upsets

for round and square bars, V, 575.

—Vibration

of bridges under balanced locomotives, XV-(3), 27.
of member, stresses due to excessive, XII-(3), 53.
stresses due to vibration of individual members, XV, 491.
time of vibration of bridges under impact, XII-(3), 27.

—Waterproofing

bridge floors, Pennsylvania Lines, XIII, 472.
of structures on New York Central Railroad, XIII, 462.
plans for waterproofing bridge floors, XI-(2), 981-990; XII-(1), 500-509, 545-563.

—Web

formula for shearing stress in, VII, 211.

—Wooden

advantages and disadvantages of, IX, 330, 371.
bibliography, VI, 37.
cost per foot, II, 139; IX, 321, 371; XVI, 893, 1180.
dead timber, IX, 318, 362.
dimensions of timbers, II, 140, 169; III, 289, 297; V, 734, 739; VI, 27, 44.
distance between decks, II, 139.
elevating for curves, method, II, 137; VI, 27.
foundations, II, 139; III, 289; V, 731; VI, 31.
impact, IX, 335; X-(1), 546, 610.
life of, IX, 372; XVI, 892.
loading, III, 295, 298; V, 744.
maintenance, cost of, II, 136, 137, 169.
methods of protecting from fire, XIV, 690.
open stringer floors, XVI, 892.
overstraining, I, 161.
packing (see Metal Details, Plans of Trestles, Spools or Separators).
solid stringer floors, XVI, 892.
use of lag screws, VII, 718; XV, 1040; XVI, 893, 1180.

Brine Drippings

from refrigerator cars, injury to signal equipment due to, IX, 766; X-(1), 235; XII-(1), 14, 231.

Brush
cut and burned, I, 150.

Buehler Process
for timber preservation, XII-(3), 436.

Buildings

—Baggage Room
in passenger stations, V, 37, 45; VI, 682; XI-(2), 1022.

—Car Barns
roof of, Chicago City Railway, reinforced concrete, XI-(2), 973.

—Ceilings
specifications for Douglas fir, Southern yellow pine, cypress, XII-(3), 559, 563, 590, 598; XIII, 882.

—Columns
(see Columns.)

—Contract
(see Contract.)

—Costs
estimate form for buildings, XII-(3), 415, 418.
of pitch and gravel roof covering, XIV, 852.
of roundhouses, IX, 182; X-(2), 1112.

—Definitions
of building terms, V, 33, 45, 56, 62.

—Depreciation
of coaling stations, VIII, 279.

—Design
engine house, principles, XI-(2), 1022, 1049; XVI, 740.
freight houses, one and two-level, comparison, XV-(2), 363; XVI-(2), 225.
principles, XV, 710; XVI, 751.
rectangular versus circular engine houses, VI, 687; VII, 625, 640.

—Doors
in warehouses on lighterage piers, location of, IV, 357.
type and location of in freight houses, III, 282.

Buildings—Continued

—Engine Houses

cost compared, IX, 182; X-(2), 112.
cost of reinforced concrete roundhouses compared with other types, IX, 182; X-(2), 112.
dampers in smoke jacks, VII, 638.
doors, VII, 630; XVI, 741.
door openings, XI-(2), 1024, 1050; XVI, 741.
heating, VI, 685, 694; IX, 170; X-(2), 1118, 1135; XVI, 742.
lighting, IX, 172, 210; XVI, 743.
principles of design, XI-(2), 1022, 1049; XVI, 740.
rectangular versus circular, VI, 687; VII, 625, 640.
removal of smoke jack from, X-(2), 1123, 1132.
requirements for drop pits, VI, 685, 693.
requirements of, VI, 684, 691; XI-(2), 1049.
smoke jacks for, VI, 629; X-(2), 1133; XVI, 742.
systems for removing smoke, ventilating, heating, etc., X-(2), 111.
use of cranes in, IX, 171.
use of reinforced concrete, IX, 166, 201; X-(2), 1109, 1110, 1114.
ventilation, IX, 170; X-(2), 1118.

—Freight Houses

and team tracks in New York, III, 276.
—in Chicago, III, 278.
—in St. Louis, III, 279.
arrangement of tracks at freight houses, III, 261, 263.
comparison of investment per car and interest charges per ton, of single and double-deck freight houses for different land values, XV-(2), 383.
cross-section of double-deck freight house, IX, 533.
description of an oval house, utilizing an odd piece of ground, IX, 533.
discussion of freight warehouses, double-deck freight houses and local city freight houses, IX, 532; X-(1), 254.
double-deck, advantages, with typical example, IX, 532.
driveways and teamways at Chicago, III, 275.
effect of length of freight house on cost of operation, XV-(2), 374; XVI-(2), 242.
fifty-eight freight stations of 24 railroads located in 17 cities, XV-(2), 384.
fire protection, III, 261, 269, 271.
floors, XIV, 879, 1084.
handling freight in four-story house, capacity and costs, XV-(2), 372.
inbound, requirements, III, 261, 269, 271.

Buildings—Continued

—Freight Houses

investigation of methods and cost of work and types of houses, XV-(2), 363; XVI-(2), 242.
lighting, III, 262, 265.
measurement of trucking wagons at Chicago, III, 274.
one- and two-level, compared, XV-(2), 363; XVI-(2), 225.
outbound, location, size, type, etc., III, 263, 268, 269.
outbound, suggested principles of practice, XII-(1), 236.
plan of Newark warehouse, IX, 563.
plans of freight houses at various points, X-(1), 254, 258, 262.
platforms to, III, 262, 265, 281.
possible development from one- to two-story, XV-(2), 378.
principles covering design, XV, 710; XVI, 751.
problems in planning and arranging freight stations and moving freight through stations, XV-(2), 363; XVI, 963.
sheds, II, 158.
storage needed in inbound, III, 262.
storage room at inbound freight houses, need for, III, 262.
trucking in, XVI-(2), 226, 227, 228, 230, 231.
trucking, sequence of operations, distribution of costs and study of methods, XVI, 226.
types of inbound and outbound freight houses, III, 268.
width, III, 269.
widths, platforms, driveways, street grades, width and capacity of wagons and length occupied by standing team, in nine large cities, III, 269.
with transfer platforms, X-(1), 259, 261, 262.

—Fire Protection

desirability, XII-(2), 610.
fire resisting qualities of roofing, XII-(1), 610, 617, 622.
in freight houses, III, 262, 265; XVI, 755.

—Floors

freight house, XIV, 879, 1084.
shop, XV, 715; XVI, 757, 759.
specifications for Douglas fir, Northern pine, Southern yellow pine, cypress, XII-(3), 558, 573, 589; XIII, 882.
standard sizes, XII-(3), 563-598.
wood block for freight house, XIV, 880.

—Heating

formula for determining heating surface of boilers, X-(1), 741.
method of heating medium-sized passenger stations, XVI, 774.

Buildings—Continued

—Heating

roundhouses, VI, 685, 694; IX, 170; X-(2), 1118, 1135; XVI, 742.
signal towers, XVI, 776.
storing coal for heating passenger stations, XVI, 777.

—Instructions

rules governing bridge and building foremen, X-(1), 53-63; XI-(1), 40; XII-(1), 61-91; XIV, 65; XV, 66.

—Joists

common, specifications for Douglas fir, XII-(3), 562.
standard sizes, XII-(3), 563.

—Lath

byrkit, specifications for Southern yellow pine, XII-(3), 598.

—Lighting

engine houses, XI-(2), 1026.
freight houses, III, 262, 265.
passenger stations, XVI, 777.
station platforms, XVI, 779.
warehouses on piers, by windows and artificial, IV, 359.

—Lumber

(see Various Kinds.)

—Maintenance

accounts affected by volume of traffic, XIV, 581, 1129.
coaling stations, VIII, 279.
special structures, XVI-(1), 108.

—Moldings

specifications for Southern yellow pine, XII-(3), 592.

—Oil Houses

requirements, XI-(2), 1027, 1054; XVI, 745.
typical, recommended, X-(2), 1126, 1136; XI-(2), 1037; XVI, 745.

—Partitions

specifications for Douglas fir, cypress, XII-(3), 559; XIII, 882.
standard sizes, XII-(3), 563.

—Passenger Stations

baggage rooms, V, 37, 45; VI, 682; XI-(2), 1022.
description and analysis of the working capacity of Kansas City Union Station, XVI, 959.

Buildings—Continued

—Passenger Stations

description of typical in 23 cities, XI-(2), 1270; XII-(1), 254.
distribution of space in passenger stations in cities of ten to fifteen thousand population, V, 38.
facilities essential in order to avoid delay, XII-(1), 237.
handling of baggage and express, XII-(1), 237, 269.
lighting, XVI, 777.
lighting platforms, XVI, 779.
number of trains which can be handled per hour per track through, XII-(1), 238.
terminal stations, two-level and loop types, XI-(2), 1250.
ticket office, V, 37, 45; VI, 682; XI-(2), 1022.
toilet rooms in, V, 37, 45; VI, 682; XI-(2), 1022; XVI, 781, 782.
situation plans and business handled at six large stations, XIV, 925.
waiting rooms, V, 36, 45; VI, 682; XI-(2), 1022.
working capacity, three methods of graphical analysis of throat and station tracks, XIV, 914.

—Platforms

and tracks, in various large cities, XI-(2), 1274-1308.
instructions regarding, XIV, 67, 1037.
lighting, XVI, 779.
moving, for handling freight in a freight house, IX, 534; XI-(2), 1266.
to freight houses, III, 262, 265, 281.
typical, at freight houses in nine large cities, III, 269.
width, at freight houses, III, 269.

—Plumbing

sanitary provisions at medium-sized stations, V, 37, 45; VI, 682; XI-(2), 1022; XVI, 780, 781, 782.

—Porch

columns, turned, Douglas fir, XII-(3), 561.
decking, specifications for Douglas fir, XII-(3), 559.

—Records and Reports

bridge and building foremen's books, II, 316; V, 231, 251, 255.

—Reinforced Concrete

coaling stations, X-(2), 1109; XI-(2), 1027.
for roofs of roundhouses, X-(2), 1110, 1129.
use of for roundhouses, IX, 166; X-(2), 1109, 1131.
(see Concrete.)

Buildings—Continued

—Removal of
clearing, IV, 21; XI-(2), 1064; XVI, 567.
—payment for, IV, 21, 91; XI-(2), 1064; XVI, 567.

—Repair Sheds
freight car, VIII, 269.
plan of typical, VIII, 278.

—Rest House
arrangement of shower baths in, XVI, 772.
requirements, XVI, 766.

—Roof Covering
asphalt, rock, or mastic, description, XIV, 842.
asphalt roofing, qualities, XII-(1), 589; XIV, 840.
bituminous materials for, XIV, 846.
corrugated iron or steel, XII-(1), 607; XIV, 864.
felts for, XII-(1), 595; XIV, 846, 847.
fire resisting qualities of roofing tested, XII-(1), 617, 622.
flashings, XIII, 889; XIV, 849.
for engine house, XII-(1), 601, 605, 606; XIV, 849, 850, 863; XV, 707; XVI, 749.
jute for, XIV, 847.
maltha, XIV, 842.
metal, disadvantages, XIV, 750.
patent shingle, XI-(2), 1043; XII-(1), 607; XIII, 888; XV, 708; XVI, 749.
petroleum residuals from different fields and qualities of each, XIV, 842.
ready roofing, XI-(2), 1043; XVI, 749.
sheet lead, copper and nickel alloy, XII-(1), 608.
slate, XI-(2), 1038; XII-(1), 606.
specifications for coal tar pitch, XIV, 850.
tin, XI-(2), 1043; XII-(1), 607.

—Roof Gutters
metal, XIII, 888; XIV, 867.

—Round House
(see Engine House.)

—Scantling
common, specifications for, Douglas fir, XII-(3), 562.

—Shiplap
specifications for, Douglas fir, XII-(3), 561.

Buildings—Continued

—Shop
types of floors, XV, 716-723; XVI, 717-766.
(see also Repair Sheds.)

—Shower Baths
arrangement of in rest houses, XVI, 772.

—Siding
bevel, specifications for, XII-(3), 559, 572, 592.
car roofing, siding and lining, specifications, XIII, 883.
drop, specifications, XII-(3), 559, 591.
standard sizes, XII-(3), 564, 592, 599.

—Slow Burning
construction, I, 46.

—Smoke Jacks
for roundhouses, X-(2), 1125.

—Specifications
essential elements to be embodied, V, 43.
for coal tar pitch for roof covering, XIV, 850.
should not be loaded with dimensions, V, 47.
(see also Grading of Lumber.)

—Stations (Passenger)
general requirements, V, 37, 45; VI, 682; XI-(2), 1022; XVI, 781, 782.
(see Passenger Stations.)

—Storehouses
and storage yard for supply department, XIV, 1018.

—Supervisors
rules governing, VIII, 26; XI-(1), 39; XIV, 65.

—Tool Houses
section, XI-(2), 1004, 1054; XVI, 746.

—Underwriting
tests and investigations at underwriters' laboratories, XII-(1), 613, 616.

—Ventilators
for roundhouses, X-(2), 1125.

Buildings—Continued

—Warehouses

at Newark, N. J., description of six-story fireproof structure, IX, 560.
automatic scales, recommended, IV, 359.
flour, for export pier, IV, 364, 370.
hay, not recommended, IV, 370.
mechanical devices for freight handling installed in warehouses, IX, 565; X-(1), 257; XI-(2), 1266; XII-(1), 236; XIV, 938; XV, 102; XVI, 962.

Burnettizing

zinc-chloride, X-(1), 617; XI-(2), 850; XII-(3), 455.

Bush Terminals

Brooklyn, N. Y., V, 186.

Byrkit

lath, specifications for, XII-(3), 598.

C

Cables

(see Ballast Unloading; Signals.)

Camber

(see Rail.)

Canting

(see Rail.)

Carbolineum

Bethell process, life of, XVI, 879.

Carbon

diagram showing carbon, phosphorus and sulphur in 25 test ingots, XIII, 681.
in blooms, XIII, 761.
rail failures, how affected by high percentage of, VII, 568.
should be increased when low phosphorus can be secured, XI-(1), 238.
steel rails, specifications, XIII, 565; XIV, 169; XV, 375; XVI, 157.
tests, XVI, 161.

Carbon—Continued

—Dioxide

variations in amount of, in tunnel ventilation, XIV, 960, 977.
(see Tunnels.)

Card Index

for bridge records, III, 366.
for drafting room, III, 369, 370.

Card Process

for timber preservation, X-(1), 657; XII-(3), 435, 441; XIII, 868, 869.

Car

—Barns

roof of, Chicago City Railway Company, built of reinforced concrete, XI-(2), 973.

—Capacity

and weight, maximum loading per car and per foot of track, VI, 241.

—Cleaning

(see Yards.)

—Coupling

passenger coaches, curvature which will hinder, XIV, 1091.

—Cut List

and other systems for indicating destination of cars to towerman, XV, 142.
use of recommended in hump yards, XIV, 937, 1095.

—Dump

coal car dumping machine, V, 161, 165.
hopper bottom, II, 292; III, 63.
types, II, 292; III, 63.
(see also Ballast Unloading.)

—Ferry

transfer of New Haven Railroad at Harlem River, history of its inception and development, V, 206.

—Floats

freight stations for handling freight from car floats, IV, 364.

Car—Continued

—Hand

rules governing use of, XIV, 69, 1042.
types, II, 289; III, 62.

—Handling (Costs)

cost of moving through hump yards compared with poling and push-and-pull methods, VI, 76; IX, 583; XVI, 986, 1190.
effect of length of freight house on cost of operation, XVI-(2), 242.
(see also Yard Operation.)

—Icing

description of ice storage house, natural ice, elevator, crushing plant, and icing platform, V, 174.

—Impact from

car springs, calibration of, XI-(1), 153.
flat wheels under cars and effect on impact on structures, XII-(3), 38.

—Lining

specifications for, XIII, 883.

—Loading

cost of loading gravel ballast, X-(1), 695.
preparation and delivery of ballast, X, 678, 681, 685, 695, 697.

—Push

types, II, 289; III, 62.

—Repairs

spacing of car repair tracks, VI, 580.
special freight car repair shop, VIII, 278.
type of car repair yard, III, 268.

—Resistance

(see Resistance.)

—Roofing

specifications for, VIII, 883.

—Shops

special freight car repair shop, VIII, 278.

—Springs

calibration and recalibration of car springs, XI-(1), 154, 158.

Car—Continued

—Yards

(see Yards.)

Castings

of grey iron, specifications for, X-(1), 164.
machinery steel, specifications for, X-(1), 166.
malleable iron, specifications for, X-(1), 166.
requirements for steel castings by different specifications, VI, 270.
semaphore, desirability and practicability of adopting a single type, III, 122.
specifications for cast-iron and steel castings, VI, 269.

Catalpa

plantation of the Illinois Central near New Orleans, XVI, 995.

Catenary

stresses, formulas, XII-(1), 215.

Cattle-Guards

(see Stock-Guards.)

Ceiling

(see Buildings.)

Cement

American, description of and qualities of each, XI-(2), 998.

—Analysis

chemical, VI, 709.

—Classification

of the different kinds, II, 67.

—Coating

of concrete walls, V, 661.
waterproofing by, XV, 537, 1060.

—Consistency

normal, VI, 711.

—Fineness

degree of fineness of grinding as affecting quality, II, 98.
of cement, IV, 390, 392, 402, 425; V, 605; VI, 706, 707, 710.

Cement—Continued

—Formulas
specific gravity of cement, VI, 710.

—Green
injury to concrete from using green cement, II, 92, 93.

—Grouting
method of grouting crushed stone in tunnel under Chicago River at LaSalle Street, XIII, 100.

—Mortar
for laying stone, III, 302.
for pointing, III, 302.

—Natural
specifications for, IV, 389; V, 605, 645; VI, 704, 726.

—Portland
cement concrete and reinforced concrete, X-(2), 1338; XII-(1), 479.
from Pennsylvania, misnomer, II, 93.
specifications for, IV, 391; V, 605, 645; VI, 704, 726.

—Sampling
cement, IV, 389, 392, 398; V, 605, 607; VI, 708.

—Set
of cement, IV, 390, 392, 404, 427; V, 606, 608.
specific gravity apparatus, LeChatelier's, VI, 709.

—Specifications
cement concrete, III, 304.
for Natural and Portland, IV, 389; V, 607, 647; VI, 704, 726.
for testing cement, IV, 389, 392, 397; VI, 708.

—Specific Gravity
apparatus to determine, VI, 709.
cement testing, VI, 709.

—Tests
boiling, its usefulness, II, 97.
boiling water test, V, 606, 646.
for concrete work, II, 94.
of cement mixed with sand, IV, 420.
of cement mixed with crusher dust, V, 640.
of cement, cost of, II, 99.

Cement—Continued

—Tests

of cement by boiling, and its relation to concrete which failed, II, 97.
of reinforced concrete beams, V, 621.
time of setting, VI, 713.

—Vicat Needle

description of, IV, 406; VI, 711.

—Weight

of cement, IV, 389, 391, 423; V, 605, 607; VI, 706.

Centrifugal Force

of engines used in impact tests, at sixty miles per hour in per cent. of static load on drivers, XII-(3), 135.
unbalanced, XI-(1), 667, 692, 693, 694.

Charts

for water service work, XI-(2), 1128; XII-(2), 415, 418, 421.
standard sizes of drawings on Pittsburgh & Lake Erie Railroad, II, 372.
track, VII, 278.

Chatts

(see Ballast.)

Chert

(see Ballast.)

Chromium

(see Alloys.)

Cinders

(see Ballast; Concrete.)

Circuit

(see Electric; Signals; Track.)

Classification Yard

(see Yards.)

Clay

burning, to prevent slides, I, 35; X-(2), 1061, 1090.
(see Ballast; Roadway.)

Clearances
adopted, and list of equipment encroaching thereon, XVI, 932, 936.
diagram for through bridges, opinions from sixty-five railroads, XV, 495; XVI, 675, 1108.
diagram showing equipment encroaching on clearance lines, XVI, 936.
discussion on clearances for third rail, XII-(1), 222.
for double and single track tunnels, XI-(2), 1086.
for structures, XVI, 920.
line for equipment and third rail structures, XII-(1), 160, 166-198; XVI, 927.
of railways and of standard equipment, XII-(1), 166; XIII, 526; XIV, 1007; XV, 619-620, 1071; XVI, 927.
on through bridges, VII, 185; XI-(1), 17; XV, 495; XVI, 675, 1108.
overhead clearance lines for permanent way structures on electrified railroads, XV, 620.
plan of third rail clearances, XIII, 525-558.
proposed, and maximum equipment in use, XVI, 676.
third-rail, XII-(1), 154; XVI, 928.
Western Maryland Railroad, XV-(2), 246.

Clearing Right-of-Way
(see Roadway.)

Coach Yard
(see Yards.)

Coal
—Chutes
adjustable for loading vessels, description of typical installation, V, 167.
cars hauled up steep track by cable, discharge into bins, thence to tender, III, 157; VIII, 261, 283.
coal elevated by conveyer to pockets, thence discharged into tender, provides storage, III, 155, 159.
dumped on platform, loaded into barrows and dumped into tenders, III, 151.
in general, III, 151; VII, 258.
Northern Pacific type, III, 160.
shoveled from cars into pockets and dumped into tenders, III, 152; VIII, 259.
trestle type, IX, 166, 194.

—Consumption
acceleration and retardation, locomotive working, coal consumption, 4,000 lbs. per hour, at various speeds, XV-(2), 18.

Coal—Continued

—Consumption

and oil as fuel compared, XIII, 437.
and time lost due to rise and fall on ruling and minor gradients, XVI, 132.
cost of coal consumed by a train stop, XVI-(2), 274.
diagram showing hourly evaporation according to coal consumed per sq. ft. grate area, XI-(1), 634.
relation between evaporation and coal consumption per sq. ft. of heating surface, XVI, 140.
(see also Fuel; Locomotive; Water Service.)

—Handling (Cost)

coaling stations, description of types and cost of handling each, III, 149; VIII, 258.
cost as affected by large or small lumps, VIII, 280.
cost of by different methods of coaling engines, III, 149; VIII, 258.
cost should include coal handling, IX, 165.
interest, maintenance and depreciation of coaling stations, VIII, 279.

—Piers

and ore, on Lake Erie; brief description of 38, and equipment, V, 202.
capacity and other data, New York and Seattle, V, 192-201.
coal piers at Curtis Bay, Greenwich Point, and Lambert's Point, V, 146-155.
conditions governing arrangement of tracks connected with, V, 142.
conditions governing choice between inclined plane and engine switching, V, 142.
crane and derrick on, types in use, IV, 361.
double and single deck compared, IV, 363, 378.
general features applicable to all, V, 139.
grades of track on, V, 140.
having inclined plane on one or both sides, V, 136, 137.
inclined plane compared with switching, V, 142.
inclined plane, its advantages, method of working, etc., V, 141.
location, size and other data of coal piers in United States, V, 144.
operated by gravity, V, 139.
switchbacks on, V, 140.
track scales on, V, 139.
tracks on, suggestions, IV, 361, 363.

Coal—Continued

—Piers

typical installations, showing large number of piers, with account of conditions leading to adoption of each, IV, 142, 217.
typical lighterage and storage piers, IV, 358, 360, 362, 366, 368.
with locomotive incline, V, 135, 137.

—Plants

coal chute, III, 153, 154, 155, 159; VIII, 293.
economy resulting from combining coal handling with water pumping and softening and other plants, VIII, 281.

—Production

of the United States, XIII, 452.
waste in mining, XIII, 454.
yearly, 1856 to 1913, XVI, 1000.

—Resources

duration of the supply of the United States, XIII, 453.
of Canada, XIV, 139.
of the United States, XVI, 998.

—Stations

of reinforced concrete, general considerations, X-(2), 1109; XI-(2), 1027.
typical of various railroads, III, 151-161; VIII, 271-277; IX, 175-181.

—Tar

in creosote oil, XII-(3), 427, 433; XIII, 1042; XIV, 712; XV, 626, 1074; XVI, 825, 833.
quality of, XVI, 826, 833.
specifications for creosote-coal tar solution, XVI, 826, 833.

Cold Straightening

(see Rail.)

Columns

—Structural

Gordon's formula for unit strains, VI, 205.
specifications for Douglas fir, XII-(3), 561.
stress strain test made by Bureau of Standards, XVI, 648.
study of built-up, XIII, 96.
test of, on New York Central Railroad, XVI, 649.

Columns—Continued

—Water

diagram showing loss of head in, XI-(2), 1191-1217.
formulas and diagrams for determining loss of head through friction in pipe lines and water columns, XI-(2), 1164-1190.
friction in cast-iron pipe, XI-(2), 1214.
specifications for reinforced concrete standpipe, XIII, 413.
valve for tank or column delivery to locomotive, practice of various railroads, XI-(2), 1146.
when recommended, X-(1), 768.

Compensation

(see Curves; Grades; Signals.)

Compressed Air

use of in tunnel excavation, XV, 391, 399.

Compression

compressive strength of ties of various woods, XIII, 306.
formulas reduced to 16,000 base limit, IV, 239.
load compression curve of rail and tie-plate, XI-(2), 830.

Concrete

(see also Abutments.)

—Acid Effect

concrete, subjected to water containing acids or alkaline, XIV, 835.

—Age

at which concrete may be loaded, III, 324.

—Aggregate

for making concrete, XI-(2), 999.
proper size of stone for, IX, 656.

—Alkaline Effect

concrete subjected to water containing acids or alkaline, XIV, 835.

—Arch

plain concrete culvert, X-(2), 1345, 1348.

—Backing

concrete for stone face work, VI, 701.

Concrete—Continued

—Beams
formulas and diagrams, V, 628.
reinforced concrete, V, 632.
tests of, V, 621.

—Bibliography
on waterproofing masonry, XII-(1), 480; XIII, 459.

—Bridge
protecting and waterproofing, Pennsylvania Lines, XII-(1), 530.
seats, use of, VI, 703.
solid floor, XV, 531.
(see Bridges.)

—Building
(see Buildings.)

—Cement
(see Cement.)

—Cinder
disintegration of, XIV, 836; XV, 567.

—Coaling Station
of reinforced, X-(2), 1109; XI-(2), 1027.

—Composition
and characteristics of concrete, III, 311.

—Consistency
normal, VI, 711.
proper, IV, 437, 444; V, 611, 637, 644.

—Contraction
and expansion, III, 321; IV, 387; V, 612, 644, 657.

—Costs
comparison between temporary and permanent structures, II, 73.
of concrete, III, 307.
of concrete piles, XVI, 796, 824.

—Covering
waterproofing, XV, 537, 1060.

—Cracked
cement failing under boiling test giving work which cracked, II, 97.

Concrete—Continued

—Culverts

distribution of area in, I, 51.
economy and advisability of the use of small concrete culverts, VI, 703.
plain concrete arch, X-(2), 1345, 1348.
waterways for, XII-(3), 490, 543.
(see Culverts.)

—Design

for girder, V, 604.
reinforced concrete, XI-(2), 968.
theory and design for reinforced, V, 692; XI-(2), 1005.

—Destructive Agencies

in concrete, XI-(2), 996.

—Disintegration

of cinder concrete, XIV, 836; XV, 567.
of concrete, XIV, 833, 836; XV, 564.

—Electrolysis

(see Electrolysis.)

—Encasement

expansion joints, method of waterproofing, XV, 535.
failures with concrete, XI-(2), 996; XIV, 833.

—Failure

of cement, II, 97.
of masonry in general, XII-(1), 514.
of waterproofing of masonry, XII-(1), 482.

—Finish

of concrete surface, XV, 800, 1175.

—Fireproof

concrete as a fireproofing material, XI-(2), 1003.

—Forms

for retaining concrete, III, 322; V, 611, 653; XI-(2), 1002.

—Formulas

distribution of load on concrete floor slabs, XI-(2), 1007.
for abutments, X-(2), 1317.

Concrete—Continued

—Formulas

for determing the strength of concrete beams, V, 624, 633, 635.
for reinforced concrete beams, V, 628.
for reinforced concrete structures, XI-(2), 1014.
for waterway openings, VIII, 314; X-(2), 967.
items to be used as a basis for estimating the cost of a cubic yard of concrete, III, 329.

—Foundations

concrete substructure under crossings and tracks in paved streets, XIV, 819.
street crossings at grade in both paved and unpaved streets, X-(2), 878; XI-(2), 1238.
street crossings in paved streets, drainage, paving, substructure and conclusions, with several examples from practice, XIV, 818, 1176.
track construction and flangeways at street crossings, XVI, 443, 1043.
track construction in paved streets, X-(2), 878; XI-(2), 1238; XIV, 818, 1116; XVI, 443, 1043.

—Freezing

building concrete in cold weather, III, 325; V, 663; XI-(2), 1001.
laying concrete under water in freezing weather, II, 82, 101; XI-(2), 1001; XIII, 487, 994.
reinforced concrete laid in freezing weather, V, 665.
resistance of concrete to frost and ice, II, 72, 91.

—Girder

design for reinforced concrete girder, V, 604.
plate on solid floor bridges, XV, 531.

—Green

injury to concrete from use of green cement, II, 92, 93.

—Handling

concrete, III, 323; XI-(2), 1001.
preparation and placing concrete, X-(2), 1340; XI-(2), 1000.

—Homogeneity

of concrete, I, 53.

—Insulation

of concrete, XV, 752.

—Mixing

methods and directions for mixing concrete, III, 305; IV, 387; V, 610; XI-(2), 1000.

Concrete—Continued

—Monolithic

concrete construction, X-(2), 1314; XI-(2), 1002; XII-(1), 514.

—Mortar

for laying stone, III, 302.
for pointing, III, 302.

—Patching

and repairing concrete, XIII, 474, 990.

—Piles

advantages and disadvantages, XI-(1), 213, 214.
bearing power, XI-(1), 213, 215.
Chenoweth, XI-(1), 204, 205, 209.
concrete, XI-(1), 204.
cost, XVI, 796, 824.
description of concrete, III, 303.
Gilbreth, XI-(1), 204.
Hennebique, XI-(1), 204, 208.
injury from using green cement, II, 92, 93.
pedestal pile, McArthur, XII-(1), 299.
practice of various railroads in use of concrete, XVI, 824.
Raymond, XI-(1), 204, 210.
reinforced concrete casings, Chicago, Burlington & Quincy Railroad, XII, 300.
Ripley combination, XI-(1), 204, 212.
should dust be excluded from crushed stone used in concrete, V, 637.
surface finish, XV, 800, 1175.
types of concrete, XI-(1), 203, 211.
various reinforced concrete, XII-(1), 300-302; XVI, 798.

—Placing

preparation and placing concrete, X-(2), 1340; XI-(2), 1000.

—Plain

maximum size of aggregates for plain concrete, IX, 656.

—Plans

for abutments and retaining walls, X-(2), 1317.

—Posts

costs, probable life and other data, of eleven types, XIII, 798.
economy of concrete and metal compared with wood, XVI, 445, 464.

Concrete—Continued

—Posts
experience of railroads with, XIV, 808.
mixing concrete, oiling molds, reinforcement, curing and method of attaching wire, XIV, 814.
proportioning materials, XIV, 813.
tests of concrete fence posts at Lewis Institute, Chicago, XVI, 482.
tests of twenty concrete fence posts, XIV, 813.
types of concrete fence posts, their manufacture, tests and use, X-(2), 898, 916; XII-(3), 614; XIV, 808, 1172.
use of at Ashokan Reservoir, New York, XVI, 480.
use of in foreign countries, XI-(2), 1241.

—Proportions
for concrete, III, 305, 338; XI-(2), 1000.

—Reinforced
beams, V, 621, 632.
concrete trestles, XII-(2), 517, 520, 581.
corrosion of, XIV, 833, 837; XV, 564, 568.
designing, XI-(2), 968.
distribution of load on concrete floor slabs, XI-(2), 1007.
economy and advisability of use for small culverts, VI, 703.
formulas and diagrams, V, 628.
joints in tension, XI-(2), 999.
laid in freezing weather, V, 665.
plan of reinforced concrete water tank, XII-(3), 339; XIII, 407-412.
plan of standard reinforced concrete culvert, Chicago Great Western Railroad, X-(2), 1380; Illinois Central, X-(2), 1385; Nashville, Chattanooga & St. Louis Railway, X-(2), 1392; Virginian, X-(2), 1408.
plan of standard concrete pile trestle, XII-(1), 520-524.
plans of various concrete piles, XII-(1), 300-302; XVI, 798.
protection against fire, XII-(2), 582.
protection of embankments by means of reinforced concrete mattress, XII-(3), 540.
roundhouse, X-(2), 1114, 1117.
shrinkage, precautions, XI-(2), 1003.
specifications for steel concrete, X-(2), 1338; XI-(2), 962; XVI, 1177.
theory and design, V, 602; XI-(2), 1005.
tunnel lining of reinforced concrete, XI-(2), 1072.

—Repairing
and patching concrete, XIII, 474, 990.

Concrete—Continued

—Resistance

of concrete to frost and ice, II, 72, 91.

—Retaining Walls

failures of, X-(2), 1320.
plans and formulas for types in use, X-(2), 1317.
waterproofing, XV, 534.
whitewashing or coating, V, 661.

—Roundhouse

(see Buildings.)

—Sampling

cement, IV, 389, 392, 398; V, 605, 607; VI, 708.

—Sand

standard specifications, V, 602.
testing cement mixed with, IV, 420.
tests, V, 607, 609.

—Shrinkage

precautions against shrinkage of reinforced concrete, XI-(2), 1003.

—Signs

concrete and metal compared with wood, XV, 861.
experience of 42 roads with concrete, XVI, 444.

—Slabs

distribution of load on concrete floor slabs, XI-(2), 1007.

—Specifications

for cement concrete, III, 304.
for concrete and steel reinforcement, X-(2), 1338; XI-(2), 962; XVI, 1177.
for Portland and Natural cement, IV, 389, 391; V, 605, 607.
for standard sand, V, 602.
for waterproofing metal and masonry structures, XII-(1), 542.
(see also Cement.)

—Steel

corrosion of, XIV, 833, 837; XV, 564, 568.
specifications for steel reinforcement, X-(2), 1338; XI-(2), 962; XVI, 1177.

Concrete—Continued

—Stone

proper sizes of stone for aggregates for use in concrete, IX, 656.
should dust be excluded from crushed stone used in concrete, V, 637.

—Street Foundations

at grade in both paved and unpaved streets, X-(2), 878; XI-(2), 1238.
in paved streets, drainage, paving, substructure, and conclusions. with several examples from practice, XIV, 818, 1176.
track construction and flangeways at street crossings, XVI. 443, 1043.

—Strength

tensile strength of concrete made from clean and dirty sand, III, 313.

—Subways

method of waterproofing, XV, 533.

—Surface

finish of concrete, XV, 800, 1175.

—Tables

formulas and tables for waterway openings, VIII, 314; X-(2), 967.

—Tension

joints in tension, XI-(2), 1002.
tensile strength of cement, IV, 390, 393, 411, 430; V, 606, 609, 646; VI, 706, 707, 710.

—Tests

(see Cement.)

—Theory

and design for reinforced concrete trestles, V, 602; XI-(2), 1005.

—Ties

concrete, XIV, 743; XV, 761.
(see also Ties.)

—Trestles

reinforced concrete, X-(2), 13, 43; XII-(2), 517, 520, 581.
(see also Ties.)

Concrete—Continued

—Water Tanks

advantages and disadvantages of reinforced concrete for water tanks, XIII, 402.
reinforced concrete substructure for water tanks, XIII, 406.
specifications for reinforced concrete water tanks, XII-(3), 334; XIII, 402, 403.
specifications for standpipe, XIII, 413.

—Weight

of cement, IV, 389, 391, 423; V, 605, 607; VI, 706.

—Whitewashing

(see Whitewashing.)

Conductors

(see Electric; Signals.)

Conservation

—Bibliography

articles pertaining to the timber resources of the United States, XIII, 435.

—Canadian Regulations

for the prevention of setting fire by locomotives, XIV, 136.

—Coal

(see Coal.)

—Definitions

conservation defined, XV, 910.

—Forest Fires

Canadian regulations, XIV, 136.
damage done by forest fires, prevention and recommended legislation, XII-(3), 631.
in Canadian forests, XIII, 456.
state laws relating to, XVI, 430.
their prevention, XII-(3), 631; XVI, 1002.

—Forestry

original extent of forests in the United States, XIII, 430.
planting by Pennsylvania Railroad since 1902, XVI, 993.

Conservation—Continued

—Fuels

(see Coal; Oil.)

—Historical

account of the inception and appointment of the Committee on Conservation of Natural Resources, and its beginnings, XII-(3), 629.

—Oil

(see Oil.)

—Petroleum

(see Petroleum.)

—Reforestation

conducted by Forestry Branch, Canada, XIII, 455; XIV, 134.
in general, XVI, 989.
necessary, XIII, 430.

—Resources

(see Coal; Iron; Oil, etc.)

—Timber

(see Timber.)

—Tree Planting

catalpa plantation on Illinois Central Railroad near New Orleans, XVI, 995.
conducted by Forestry Branch in Canada, XIII, 455; XIV, 134.
experiments by railroads, species planted and results, XVI, 990.
in general, XVI, 989.
necessity for, XIII, 430.
tamarack as tie timber, experimental tree planting by Canadian Pacific Railway, XVI, 994.

—United States Regulations

state laws in regard to protection of forests from fires, XVI, 1002.

—Waste

in coal mining, XIII, 455.
in the petroleum industry, methods of preventing and lessening, XIII, 444.
of crude petroleum and natural gas in Canada and measures taken to prevent continuance, XIII, 457.

Conservation—Continued

—Water Powers

conditions under which it should be developed, XV, 907.

Contract

—Agreements

clause in form recommended by Committee on Buildings, compared with similar clause in forms of numerous railroads, X-(2), 1185.
XVI, 92.
for installing and maintaining an interlocking plant, conditions met, X-(1), 72, 213.
for sidetrack to industries, typical, III, 398, 418.
form of, X-(2), 1177.
of concrete, IV, 382.
recommended form, XII-(3), 620; XIII, 909; XIV, 701, 1144;
standard agreement form for interlocking, VIII, 72, 91; X-(1). 72, 215.
what should be embodied in, X-(2), 1176.

—Arbitration

chief engineer's decision final, XIII, 1152; XVI-(2), 255.

—Bond

form of to accompany construction contract, XVI, 101.
furnished by contractor; compared with similar clauses used by various railroads, X-(2), 1278.
to whom it should be delivered, XIII, 1065.

—Bridges

bridge fabricating and erecting, III, 221.
practice in placing railroad bridges under contract, III, 221.
recommended practice in inviting bids on bridge work, VI, 198.
which is the preferable method of letting bridge work, III, 222.
(see also Proposals.)

—Buildings

alteration clause in form recommended by Committee on Buildings compared with similar clause in forms of various railroads, X-(2), 1185.
delays due to causes beyond control of railway company, X-(2), 1276.
engineer and contractor defined, X-(2), 1276.

Contract—Continued

—Buildings
essential elements to be embodied in, V, 40.
form of building contract, V, 40; VI, 676.
should not be padded with useless or unnecessary provisions, V, 47.
standard form, VI, 675.
typical, V, 48.

—Commencement
and complete clause, X-(2), 1243.

—Condemnation
condemned material clause, X-(2), 1214.

—Contractor
defined, X-(2), 1276.
undertaking clause, X-(2), 1192.

—Defective Work
how it should be treated in contract, XIII, 1067.

—Definitions
terms defined, X-(2), 1167.

—Delays
due to causes beyond control of railroad company, X-(2), 1247.

—Discipline
order and discipline, XIII, 1069.

—Disputes
chief engineer's decision shall be final, XIII, 1152; XVI-(2), 255.

—Engineer
defined, X-(2), 1276.

—Essentials
elements of a binding contract, X-(2), 1170.

—Execution Clause
execution clause, X-(2), 1297.

—Extra Work
how arranged, XIII, 1071.
payment therefor, VI, 135, 144, 160, 164; XI-(2), 1064; XVI, 571, 1075.

Contract—Continued

—Form

construction agreement form, XII-(3), 620; XIII, 909, 1060; XIV, 701, 1144; XVI, 92.
general conditions to be embodied in, X-(2), 1170.
general, marginal headings, applicable to general conditions, typical, X-(2), 1168.
of a uniform general, X-(2), 1169.
of proposals, XV, 921.

—Industrial Track

(see also Yards; Track.)

—Insurance

insurance clause, X-(2), 1279; XIV, 1149.

—Intent of Plans

and specifications clause, XIV, 1147.

—Liens

and final estimate, XIII, 1159.
how treated, XIII, 1068.

—Marginal Headings

applicable to general conditions, X-(2), 1180.

—Omissions

in specifications and plans, XIV, 1147.

—Order

and discipline, XIII, 106.

—Payment

for cutting down embankments, IV, 114; VI, 144, 160, 164.
for excavation in water, IV, 114.
for excess in tunnel excavation, outside of cross-section limits, IV, 26, 34, 61.
for grading, IV, 25.
for grubbing for light fills, II, 15; IV, 33.
for land purchased, IV, 25, 34, 99.
for overhaul, IV, 26, 34, 66, 100, 115, 119; VI, 151; VII, 346, 353, 357, 428, 443; VIII, 313; XVI, 569.
for removal of buildings, IV, 21; XI-(2), 1064; XVI, 567.
for rock cuts, below sub-grade, IV, 22, 100; VI, 142, 144, 171; XVI, 567.

Contract—Continued

—Payment
for shafts in tunnels, IV, 35; XVI, 570.
for wells or sumps in tunnels, IV, 35, 106.
haul in tunnel excavation, IV, 35; XVI, 570.
price and payment clause, X-(2), 1252.
state laws providing for division of expense of grade crossing elimination, X-(2), 926.

—Prices
and payment clause, X-(2), 1219.

—Proposal
form of, XV, 921.
points to be specifically determined by buyers when soliciting, XI-(1), 123.
recommended practice in inviting bids on bridge work, VI, 198.

—Roadway
land purchased for, at whose expense, IV, 25, 34, 99. (See also Payment.)

—Specifications
intent of, XIV, 1147.
omissions in discussed, XIV, 1147.

—Suspension
discussion, XIII, 1155.
how contractor should be paid for losses during, XIII, 1073.
of operations, X-(2), 1219.

—Tenders
practice in placing railroad bridge work under contract, III, 231.
recommended practice in inviting bids on bridge work, VI, 198.
which is the preferable method of letting bridge work, III, 222.

—Tunnel
payment for excess excavation outside cross-section limits, IV, 26, 34, 61.
payment for shafts in tunnels, IV, 35; XVI, 570.
payment for tunnel excavation, IV, 105.

Controlled Manual Block
(see Signals.)

Conventional Signs
committee discussion covering desirable use and type recommended, XI-(2), 1105, 1137.

Conventional Signs—Continued

for bridge rivets and stresses, XI-(1), 124.
for right-of-way and topographical maps, VII, 300; VIII, 112; X-(2), 827, 870; XV, 930, 1157; XVI, 789, 1085.

Conveyors

for handling baggage and mail, XV, 112.
for handling express and parcels, XV, 115.
mechanical for handling freight on steamship docks, IX, 535; XIV, 953.

Cooper's Loading

wheel loading, various type engines, and curves of equivalent in Cooper's E loading, XVI-(2), 302.

Copper

effect of one-tenth per cent. admixture of various substances with, X-(1), 147.
properties of, in wire, XII-(1), 212-214.
(see Roof Covering.)

Corrosion

concrete encasement, XV, 412, 1045; XVI, 605.
means for securing wire fencing to resist corrosion, XI-(2), 1235; XII-(3), 614; XIII, 902; XIV, 826.
of boilers, where treated water was used, trouble, investigation of cause, remedy applied and result, XIII, 420.
of fence wire, causes leading to and means for preventing, VII, 459.
of steel reinforcement in concrete, XIV, 833-837; XV, 564.
protection of bridge floors, X-(2), 1146.
protection of iron and steel structures from, XV, 618.
rust proof process, XIII, 901.
scaling and corrosive matter in boiler water, minimum amount which will justify treatment, VIII, 610.
tests on iron and steel, XV, 695; XVI, 713.
tests on iron and steel, results of nine months' exposure of samples, with analysis and data, XV, 695; XVI, 712.

Corrugated Iron

(see Buildings; Roof Covering.)

Cost Data

—Abutments

cost for one abutment in dollars, of different types, XIII, 1127-1139.

Cost Data—Continued

—Ballast
(see Ballast.)

—Bridges
(see Bridges.)

—Buildings
estimate form for buildings, XII-(3), 415-418.
of pitch and gravel, XIV, 852.
of roundhouses built of brick, and reinforced concrete, IX, 182.

—Coal Handling
affected by large and small lumps, VIII, 280; XI, 165.
at coaling stations, III, 149; VIII, 258.
dumped on platform, barrow tenders, III, 151, 152; VIII, 259.
interest, maintenance and depreciation, VIII, 279.
of different methods of coaling engines, III, 149; VIII, 258.

—Creosote
cost and payment based on amount of oil used, XV, 631.
relative value, cost and available supply of the three grades, XIII, 1043.

—Diagrams
cost of coal consumed by a train stop, XVI-(2), 274.

—Fences
comparative cost of steel and wood, XIV, 796.
reports from 44 railroads on kind used, its life, cost and loss by fire, with discussion by committee, XIV, 791.

—Forms
record of cost of work, VII, 274, 296.

—Helper Engine
cost of, V, 702.
(see Economics of Railway Location.)

—Highway Crossings
cost of protecting and estimated losses at unprotected, II, 329.
(see also Grade Revision.)

—Masonry
comparison between cost of temporary and permanent structures, II, 73.
cost of concrete, III, 307.
cost of concrete piles, method of construction and recommendations for their use, XVI, 796, 824.
cost of concrete surface finish, XVI, 800, 1175.

Cost Data—Continued

—Moving Cars

cost of moving cars through hump yards, VI, 576; IX, 583; XVI, 986.
freight house, oval, etc., effect of length on cost of operation, XVI-(2), 242.

—Pumping

cost of fuel for various types of pumps and engines, XVI, 705.
cost of pumping water, II, 223.
cost of repairs to steam and gasoline pumping plants compared, X-(1), 774.

—Roadway

cost of helper engine, V, 702.
cost of steam shovel work, J. C. Sesser, VIII, 312.

—Steam Shovel

cost of steam shovel work, J. C. Sesser, VIII, 312.

—Ties

comparative value of different material, XV, 744.
cost of creosoted ties fitted with helical linings and screw-spikes, XV-(2), 295.
cost of cross-ties purchased in United States by steam railroads, XI-(2), 764; XII-(3), 447.
cost of maintenance of metal ties, XI-(2), 889; XII-(1), 372; XIII, 348.
of untreated cross-ties on various railroads in 1900, II, 110.
table showing cost a white oak tie must reach before it becomes economical to use; other enumerated types, VIII, 485.

—Timber Bridges

cost per foot of ballast floor trestles, II, 139; IX, 321, 371; XVI, 893, 1180.
cost per linear foot, II, 171.
cost per linear foot of creosoted ballasted trestle, built in 1899, Atchison, Topeka & Santa Fe Railway, II, 139.

—Track Maintenance

expenditure per mile of line, XVI-(2), 22.
with different types of spikes, XV-(2), 271.

—Trestles

cost per linear foot, II, 171.

Cost Data—Continued

—Water Service

comparison of cost of installing water softening plants, VI, 601, 620; VIII, 607.
cost in detail of water tanks, maintenance, etc., XI-(2), 1160.
cost of fuel for various types of pumps and engines, XVI, 705.
cost of pipe line, X-(1), 413.
cost of pumping water, II, 223.
cost of removing scale forming in boilers, II, 230.
cost of repairs to steam and gasoline pumping plants compared, X-(1), 774.
cost of water softening plants, V, 589; VI, 601; VII, 668.
cost of water tanks, foundation, frame and tub, wood and steel, X-(1), 793.
first cost, maintenance and scrap value of reinforced concrete water tank, XI-(2), 1160.

—Water Tanks

cost of different types of water tanks, XI-(2), 1160.
(see also under Water Service.)

—Wood Preservation

cost and payment based on amount of oil used, XV, 631.
cost of preservatives, II, 105.
relative value, cost and available supply of the three grades, XIII, 1043.

Counterbalancing

(see Locomotive; Impact; Rail.)

Cradle

(see Electric.)

Cranes

overhead jib, description of type used in freight houses in Great Britain, XIV, 953.
overhead traveling needed in freight house, III, 262, 265.
types of crane and derrick on piers, IV, 361.
use of in roundhouses, IX, 171.

Creosote

(see also Wood Preservation.)

—Absorption

Havelock's experiments to determine absorption of creosote X-(1), 663.
in pounds of creosote, of air-seasoned ties, XIII, 871.

Creosote—Continued

—Analysis

of creosote, by various railroads, XIV, 717.
specifications for, XI-(2), 743.
specifications for No. 2 grade, XIII, 865, 1042.
specifications for No. 3 grade, XIII, 865, 1043.
variation in weight of timber before and after treatment, VII, 49.

—Applying

general principles in applying preservatives, X-(1), 627.
in hot creosote oil, XI-(2), 739.
open-tank process, X-(1), 629.
pressure process, X-(1), 629.

—Boiling

creosote, X-(1), 667; XV, 737.

—Bridge Timbers

drying after treatment, X-(1), 637; XI-(2), 748.

—Checking

and splitting, VIII, 492.

—Coal Tar

in creosote, XII-(3), 427, 433; XIII, 1042; XIV, 712; XV, 626, 632, 1074; XVI, 825, 833.
specification for coal-tar solution, XVI, 826, 833.

—Compounds

high boiling point of creosote compounds, X-(1), 620.

—Cost

cost and payments based on amount of oil used, XV, 631.
cost of cross-ties purchased, 1907, XI-(2), 764; XII-(3), 447, 450, 452.
life and cost of creosoted ties in England and France, I, 82; VIII, 490; IX, 738; XV, 736.
relative value, cost and available supply, XIII, 1043.

—Creosoting

creosoting, X-(1), 617, 620, 630, 632, 660, 664; XI-(2), 739, 850; XII-(3), 455; XVI, 854, 859, 860.
specifications for plain, XI-(2), 740.

—Dilution

of No. 1 grade, XV, 1092.

Creosote—Continued

—Distillation
apparatus for, XII-(3), 430.
test, XII-(3), 430.

—Economy
in labor and material effected through the use of treated compared with untreated ties, XV, 728, 1122; XVI, 522, 524, 1091.

—Evaporation
loss of creosote oil in evaporation tests, XV, 648.

—Exposure
in ether, XI-(2), 812.
to action of sun, X-(1), 634.

—Foreign Practice
of treatment, XV, 735.

—Fractionation
of creosote oil, XII-(3), 432; XIII, 866; XIV, 713, 717, 1165; XVI, 872.

—Impurities
insoluble in matter, XII-(3), 427.
water in creosote oil, X-(1), 634; XII-(3), 433; XVI, 832.

—Life
experience of Louisville & Nashville Railroad with creosoted piles, W. H. Courtenay, X-(1), 632.
life of creosote compounds immersed in boiling oil, XVI, 881, 882.

—Measuring
methods for, X-(1), 621, 623; XVI, 832, 833.

—Painting
preservatives for painting and soaking; name, composition, cost, quantity, etc., II, 105.

—Piles
experience of the Louisville & Nashville Railroad with creosoted piles and timber, W. H. Courtenay, X-(1), 632.

—Plants
in Europe, I, 82; VIII, 490; IX, 738; XV, 736, 737.
principal wood treating plants, II, 107; III, 99; V, 75; IX, 737.

Creosote—Continued

—Poison Effects
protection against poisoning men in handling treated ties, XVI, 548, 553.

—Precautions
to be observed, XV, 627, 632, 1093; XVI, 827, 833.

—Processes
Allardyce, XI-(2), 767, 775; XVI, 882.
Bethell, XVI, 879.
Buehler, XII-(3), 436.
Burnettizing, X-(1), 617.
Carbolineum, XVI, 880.
Card, X-(1), 657.
Creosoting, X-(1), 617.
Guissani, XVI, 876, 879.
Hasselman, X-(1), 619; XI-(2), 768, 771, 775.
Kyanizing, X-(1), 618.
Lowry, X-(1), 665; XI-(2), 850; XII-(3), 436; XIII, 870, 871.
open-tank method, X-(1), 659.
Rueping, X-(1), 617, 660, 664; XI-(2), 850; XII-(3), 439; XIII, 872; XVI, 870.
Rutgers, XI-(2), 816.
Spirittine, XI-(2), 769.
Thilmany, XVI, 854.
Vulcanizing, XVI, 859.

—Quantity
injected, X-(1), 617; XI-(2), 750; XIII, 1050.

—Sampling
of oil for water content, XVI, 832, 833.

—Specifications
for analysis, XI-(2), 743.
No. 2 grade oil, XIII, 865, 1042.
No. 3 grade oil, XIII, 865, 1043.
plain creosoting, XI-(2), 740.
standard specifications for creosote oil, X-(1), 621, 673; XI-(2), 737; XII-(3), 430; XIII, 865.
tie treatment, IX, 740.

—Specific Gravity
of creosote oil, XII-(3), 430, 433; XIII, 1049.

Creosote—Continued

—Supply
of creosote in the United States, X-(1), 670, 674; XI-(2), 749.

—Tests
apparatus for, XII-(3), 430.
distilling, XII-(3), 430.

—Ties
(see also Ties.)

—Volume
factors for determining, X-(1), 622, 630.

—Water Gas
creosote from, XIV, 712; XV, 625.

—Water in
creosote oil, X-(1), 634.

—Waterproofing
properties of creosote oil, IX, 761.

—Wood
weights of, air dried, XI-(2), 802.

—Zinc
creosoted, life of, XVI, 879.
emulsion treatment, specifications for, XI-(2), 741.

—Zinc-Tannin
(see Zinc.)

Cribbing
protection of embankments by use of cribbing, sandbags, etc., II, 20; X-(2), 1052, 1066, 1076.
(see Roadway.)

Critical Speed
(see Bridges.)

Cross Arms
accidents to, XII-(1), 202.
angle travel of semaphore arm, VII, 525.
preservative method, XII-(1), 211.

Crossings
(see also Grade Elimination; Track Elevation.)

Crossings—Continued

—Bells
efficiency of at highway crossings and cost of installing, II, 327; VIII, 527, 532.

—Double Slip
(see Switch.)

—Farm
gates for, V, 384, 400.
plan, VIII, 530.

—Foundation
railroad, I, 150; II, 279.

—Grade
(see Grade Crossings.)

—Highway
cost of, II, 329.
elimination in Chicago, I, 169.
for paved and unpaved streets, country roads and private or farm roads, X-(2), 878; XI-(2), 1237-1246.
gates for, types, advantages and cost, II, 328.
instructions regarding, XIV, 67, 1036.
need of lights, some objectionable, II, 328.
plans, VIII, 527-530; XIV, 818, 1176.
safety signs for, conditions of installation, II, 326.
state laws affecting, II, 383.
where occupied by city or interurban lines, dangers and precautions, II, 328.
(see also State Laws.)

—Lighting
need of lights, some objectionable, II, 328.

—Manganese
plan of manganese frogs and crossings, XVI, 719-725.

—Overhead Electric
specifications for, XIII, 512, 522, 999; XIV, 988; XVI, 939-948.
wires, size and material for overhead crossings, XII-(1), 209.

—Plank
specifications for, XII-(3), 605.

—Railroad
instructions regarding, XIV, 67, 1036.

Crossings—Continued

—Signs

economy of metal and concrete compared with wood, XVI, 444-446.
metal, XV, 874.
practice of 47 railroads, post, setting, blade, angle, ground, letter, cost and inscription, XV, 864.
recommended type, XV, 872, 1139.

—State Laws

abstract of state laws regarding, V, 403.
trespass, laws relating to, custom of railroads and recommended practice, XV, 880.

—Street

track construction at street crossings, XIV, 823.

Crossovers

arrangements of crossovers and slotting of interlocking signals in conjunction with automatic signals, IX, 43.
main line, XV, 569; XVI, 715, 728.

Cross-Section

alterations in grade, line, cross-sections, etc., claims for, XVI, 571.
American practice for single track, plans of, XV, 392, 399.
clearing in advance of cross-sectioning, IV, 33, 87.
increase for curves, XI-(2), 1065, 1086; XVI, 573.
loading on ballast and sub-grade and essential width of roadbed to furnish base and support, VIII, 57.
roadbed adequate for track superstructure equal to present loading, VIII, 57.
roadbed, II, 14; VI, 136.
tunnel, XI-(2), 1065, 1086, 1091, 1095; XII-(3), 544; XV, 392.

Cross-Ties

(see Ties.)

Crushed Rock

(see Ballast.)

Culverts

(see Waterways.)

Curves

compensation for, II, 21.
curve compensation tests on Baltimore & Ohio Railroad, XI-(1), 657-662.

Curves—Continued

—Central Angle

formula for determining negative value of one degree of central angle, XI-(1), 682.

—Compensation

for curves, II, 21.
opinions on proper compensation for curvature, XI-(1), 664.
table of curve compensation tests on Baltimore & Ohio Railroad, XI-(1), 657-662.

—Coupling Cars on

curvature which will hinder coupling passenger coaches, XIV, 1091.

—Easement

form of record of easement and elevation of curves, II, 301.
instructions regarding, XIV, 66, 1030.
or special, II, 22; V, 667.

—Economic Comparison

formula for comparing economy of temporary and permanent structures, II, 73.
reduction of gradient, and elimination of distance, curvature, and rise and fall, on Union Pacific Railroad, J. B. Berry, V, 689.

—Elevation

derailing due to excessive, II, 264.
does it increase train resistance, III, 82.
of curves, I, 146; II, 262; III, 56-78; V, 529; VI, 753; X-(1), 447; XII-(1), 402.
of outer rail on curves for equipment with different centers of gravity, XV, 570.

—Flange Pressure

uniformity of flange pressure against rails, XI-(1), 680, 692.

—Formulas

for field use, XII-(1), 424.
for widening gage on curves, II, 276.
Holbrook spiral, II, 256.
Talbot's transition spiral, II, 303.
vertical curves, III, 58; V, 532.

—Gage

formula for widening on curves, II, 276.

Curves—Continued

—Gage

required gage for given wheel base on different curves, IX, 394, 397.
wide, due to worn rail, X-(1), 398; XI-(2), 935.
widening on curves, I, 147; II, 273; III, 59; V, 534; IX, 389, 422; XVI, 733.

—Improvement

grade and curve improvement work outside cities, III, 29; IX, 602, 603, 610.
organization for grade and curve improvement work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.

—Maximum

allowable curvature in throat tracks at stations, XIV, 1092.
curves of short radius and on heavy grades operated by geared locomotives, XVI, 968.
determination of maximum degree, IV, 9; XI-(1), 678, 681.
—when to use, XI-(1), 679, 682.
negative value of sharp, XI-(1), 680, 690, 693.
—temporary use of, XVI, 106, 112.
on tracks where passenger coaches are coupled, XIV, 1091.
radius of curves operated over by passenger trains in terminals, XI-(2), 1251.
speed of trains around, XV, 570.
tracks with seven per cent. grades and sharp curves worked by geared locomotive, XVI, 968.

—Rail

curving rails for, II, 266.

—Rail Wear

on curves, VIII, 248; IX, 772; XI-(1), 692, 697, 698, 699, 700, 701.
—section machine, XI-(1), 704, 708.
on tangents and curves, from observations on the Northern Pacific Railway, XI-(1), 696-698.
(see also Rail.)

—Resistance

does elevation of curves increase train resistance, III, 82.

—Reverse

reverse curves, XIV, 623.

—Safety

safety of curves, II, 267; V, 728; XI-(1), 678, 732.

Curves—Continued

—Speed on
of trains around, XV, 570, 580.

—Spiral, Transition
curving rails for, II, 266.
discussion and findings, X-(1), 417.
functions of, XIV, 120.
Holbrook, II, 256.
lengths, corrections, value and angles of, VII, 652.
minimum curve spiraled on different roads, X-(1), 412.
New York Central standard, X-(1), 450.
proper length of, X-(1), 446.
selecting length for, Frank H. Carter, XII-(1), 439.
spiral data and spiral functions, XII-(1), 424, 429; XIV, 121-129.
spiralling, I, 146; II, 253, 255; III, 55, 68; V, 528; VI, 753; VII, 643; X-(1), 443, 446, 477; XII-(1), 402, 428; XVI, 731.
Talbot's transition spiral, II, 303.
true properties of a spiral as given by several authors, X-(1), 487.

—Superelevation
(see Elevation.)

—Tunnel
increase for tunnel sections, XI-(2), 1065, 1086; XVI, 570.

—Value of
capitalized value of rise, curvature and distance by different rates of interest, XVI, 122.
discomfort to public, V, 727.
fixed values for curvature, distance, rise and fall of gradient, impossible, XIII, 905.
insurance value, V, 728.
negative, V, 705, 718, 723, 724, 726, 727; VIII, 248; XI-(1), 681, 693.
sharp, negative, XI-(1), 680, 692, 693.
—objections to, XI-(1), 666, 668, 693.
—slowing down at, cost of, XI-(1), 693; XVI-(1), 107, 114.
—temporary use of, XVI-(1), 106, 112.
(see also Economics of Railway Location.)

—Vertical
formulas for, III, 58; V, 532, 540, 572.
vertical curves, XVI-(1), 107, 113.

—Yard
curvature which will hinder coupling passenger coaches, XIV, 1091.

Curves—Continued

—Yard
radius of operated over by passenger trains in terminals, XI-(2), 1251.
short of radius and on heavy grades operated by geared locomotives, XVI, 968.

Cuts
(see Excavation.)

Cypress
as tie timber, XII-(1), 390.
classification of knots in cypress, XIII, 875.
defects in cypress lumber and timber, XIII, 875.
life of untreated cypress ties, V, 76.
pecky cypress, XIII, 878-881.
specifications for cypress ceiling, XIII, 882.
specifications for cypress finishing, XIII, 881.
specifications for cypress lumber and singles, XIII, 875.
specifications for cypress partition, XIII, 882.
specifications for cypress pickets, XIII, 883.
specifications for cypress siding, XIII, 882.
specifications for cypress tank stock, XIII, 879, 880.
standard lengths and sizes, XIII, 878.

D

Damages (Persons and Property)
responsibility for, VI, 134, 158.
to switches by engines, I, 154.

Dating Nails
for cross-ties, X-(1), 617, 637; XI-(2), 748; XII-(3), 427, 434.
inspection hammer and dating nails, XVI, 552.
(see Ties.)

Decay
around bolt holes and places where treated wood is cut through, exposing untreated, X-(1), 633; XII-(3), 427.
causes of, II, 115.
formula for average expense to maintain track due to age and decay, XIV, 585.
of ties, IX, 695.

Deeds
register of title deeds, form for, VI, 655-659.
right-of-way and deed records, how arranged and cared for and what shown, II, 318, 325; VI, 651, 658, 672.

Definitions
(see Ballast; Roadway; Ties, etc.)

Deflection
(see Bridges; Rail, etc.)

Deflectometer
and instrument for measuring effect on bridge of moving trains, instrument and working described, IX, 222.
description of instrument, XII-(3), 16.
records taken in impact tests by committee, reproductions, XII-(3), 203.

Departure Yard
(see Yards.)

Depreciation
(see Buildings.)

Derails
plan of derail pipe-connected to switchstand, IX, 396.
(see Switches.)

Derrick
for handling freight at terminals, XII-(1), 247.
on lighters at water terminals, IV, 361.
types of crane and derrick on piers in use, IV, 361.

Diagrams
(see Bridges; Buildings, etc.)

Docks
(see Piers; Wooden Bridges and Trestles.)

Doors
(see Buildings.)

Double Slip
(see Switch.)

Douglas Fir
(see Fir.)

Drafting Room Records
card index for, III, 369, 370, 371, 372.

Drainage

areas by various formulas, XII-(3), 485.
by tile drains, how placed, XVI, 1167.
cleaning and repairing, X-(2), 1095.
draining of water pockets in roadbed, and prevention, IX, 606; X-(2), 1029, 1069, 1076, 1080, 1088, 1096; XVI, 595.
glazed bell pipe recommended, VIII, 536, 599.
in tunnels, by terra cotta or sewer pipe, XI-(2), 1066.
instructions for drainage area surveys, X-(2), 1001, 1005.
intercepting ditches (or surface), II, 17; IV, 11, 23; IX, 609, 610; X-(2), 921, 1047, 1066, 1093, 1094, 1105; XVI, 567.
James Dun formula, X-(1), 977; XII-(3), 484.
notes, X-(2), 1002.
of roadway, instructions concerning, XIII, 66, 920.
protection of embankments by blind drains, II, 19; X-(2), 1059, 1069.
roadbed subdrainage, II, 17; IV, 11, 12; VI, 150; X-(2), 920. 922, 1068, 1080, 1084, 1086, 1093, 1094, 1105; XVI, 573.
rules for, XIII, 66.
run-off, Burkli-Zeigler and McMath, X-(1), 982.
under crossings and tracks in paved streets, XIV, 818.

Drawbar Pull

(see Locomotive.)

Drawbridge Protection

(see Bridges; Signals.)

Drawings (Scale of)

American practice for single and double track tunnels, XV, 392, 399.
approval of 34 features of signal work, X-(1), 169-174.
(see also Records and Accounts.)

Drawspans

(see Bridges.)

Drift

—Snow

methods of preventing drifts and removing snow and ice, X-(2), 881; XII-(2), 1239.

—Tests

(see Rail.)

Drilling

(see Rail; Track; Water Service.)

Drills (Power)
first use of, IV, 15.

Driveways
and teamways at freight terminals at Chicago, III, 275.
in yards at freight houses in nine large cities, width of, III, 269.
(see Yards.)

Drop Siding
(see Buildings.)

Drop Tests
(see Rail; Ingots, etc.)

Ductility
(see Rail.)

Dump
(see Unloading.)

—Cars
(see Cars.)

—Machinery
description of types of coal-car dumping machines, V, 159, 161, 165.

—Platforms
dump platforms for push cars, II, 292; III, 63.
(see Platforms.)

Dun Formula
Dun's drainage table, results, XII-(3), 486, 487.
(see Waterways.)

Durability (Life)
(see Bridges; Concrete; Piles, etc.)

Dynamite
(see Explosives.)

Dynamometer
recommendations for, VIII, 242; XI-(1), 665.
tests on Baltimore & Ohio Railroad, application to tonnage rating, R. N. Begien, XIV, 589, 1110.
tests to determine train resistance, XI-(1), 648.

Dyke System
David Neale system, XII-(3), 533-540.
for slides, X-(2), 1025.
(see Embankment.)

E

Earnings

grades and alinement, elements of economy, earnings often controlling, III, 17.

Earthwork

(see Embankment; Excavation; Grading.)

Easement Curves

(see Curves.)

Economics

—Acceleration and Retardation

curves, III, 25; V, 718; XI-(2), 1316, 1325, 1326; XV-(2), 5.
formulas, IX, 776; XIV, 603.
tables, III, 26; V, 718; IX, 781; XIV-(2), 10, 17; XV-(2), 6, 18, 20.

—Ballast

(see Ballast.)

—Comparisons (Review)

basis of variation of operating costs applicable to design of railway location, A. C. Dennis, XI-(1), 685, 695.
comparison of operating costs on two or more proposed lines, XI-(2), 319.
complexity of subject and vast field embraced by scope of work, VI, 18; VIII, 143, 250.
cost of helper engine mile, V, 702.
definite mathematical solution seldom possible, VIII, 149.
designing an economical plant for handling, XVI-(1), 104, 110.
difficulty in making estimates of traffic, XI-(1), 694; XVI-(1), 110.
discounting the future in estimating traffic, VIII, 146, 148.
economic value of a location, formula, XVI, 104.
estimates of traffic, II, 22; VIII, 146; XVI-(1), 105, 110, 111.
expensive improvements justify time for accurate compensation, IX, 789.
fixed values for curvature, distance, rise and fall of gradient impossible, XIII, 905.
formulas, tables and diagrams for estimating annual expense on basis of equivalent ton miles, XIV, 585, 588, 590.
freight train mile costs, V, 693, 698; XI-(1), 691.
location of station buildings, XVI-(1), 113.
maintenance of equipment, IX, 786, 787, 796; XI-(1), 691, 693; XV-(2), 13; XVI-(1), 108.

Economics—Continued

—Comparisons (Review)

maintenance and operation of special structures, XVI-(1), 108.

maintenance of way and structures accounts affected by depreciation and decay, XIV, 582.

—accounts affected by volume of traffic, XIV, 581, 1129.

—accounts due to both main and sidetrack usage, XIV, 580.

—consideration of and analysis, as affecting problems of economics of railway location, V, 694; IX, 787; XI-(1), 694; XIV, 580, 1129; XV-(2), 13; XVI-(1), 108.

negative value of distance, curvature and line resistance, XVI, 118, 119.

negative value of distance, V, 703, 718, 722, 726; XVI-(1), 108.

passenger train mile costs, XI-(1), 691.

physical characteristics of a railway, effect upon operation of trains, John D. Isaacs and E. E. Adams, XI-(2), 1311.

relative amount of mechanical wear caused by engines and cars, passenger and freight trains, IX, 787; XIV-(1), 581, 582, 1129, 1131, 1134, 1135; XV-(1), 915.

rise and fall, fuel consumption, XIV-(2), 15; XV-(2), 3; XVI-(1), 108.

temporary line, heavy traffic to justify abandonment, VIII, 147.

temporary work thrown away, VIII, 146, 148.

time as an element in considering grade reductions, A. K. Shurtleff, IX, 779; XI-(2), 1320.

time curves or diagrams, use of for determining economical gradient, IX, 775, 785, 790.

time entering and leaving sidings, VIII, 249, 250; IX, 775.

time estimating (see Speed Curves or Diagrams), XI-(2), 1320; XIV-(2), 7, 10, 11; XV-(2), 8; XVI-(1), 106, 112.

time greater for the heavy trains on reduced ruling gradients than for lighter trains on heavier ruling gradients, VIII, 249, 250; IX, 775, 776; XI-(1), 689; XV-(2), 8, 12, 17; XVI-(1), 105, 112.

time limiting train loads, VIII, 249, 250; IX, 775, 776; XI-(1), 689; XI-(2), 1332; XIV, 1113, 1116; XV-(2), 8, 12, 17; XVI-(1), 105, 112.

time loading, relative economy in Baltimore & Ohio locomotives, diagrams, IX, 798.

time lost at stops, VIII, 249, 250, 253; IX, 775; XI-(1), 689; XIV-(2), 7; XV-(2), 9; XVI-(1), 105.

ton miles as a unit for estimating operating costs, XIII, 906.

ton mile adjusted as a unit for estimating operating costs, XI-(1), 711; XI-(2), 1328, 1330, 1333.

tonnage in each direction to be considered, V, 672; IX, 789.

Economics—Continued

—Comparisons (Review)
train mile as a unit for estimating operating costs, XI-(1), 691, 694, 695, 711; XIII, 905; XIV, 581; XVI-(1), 107.
use of temporary line as a branch or freight track, VIII, 147.
value of double track in saving time, VIII, 249; IX, 775; XI-(1), 690; XVI-(1), 105, 112.
(see Location.)

—Curvature
(see Curves.)

—Distance (Value)
negative value of distance, curvature and line resistance, XVI, 118, 119.

—Formulas
economic value of a location, XVI, 104.
negative value of distance, curvature and line resistance, XVI, 118, 119.

—Freight Houses
effect of length of freight house on cost of operation, XV-(2), 374; XVI-(2), 242.
possible development from one- to two-story freight houses, XV-(2), 378.

—Fuel Consumption
firing up at engine houses, XIV-(2), 4, 5, 6; XV-(2), 27.
foot-tons of work performed as a measure of, XI-(1), 691; XVI-(1), 108.
for movement of locomotive alone, XVI-(1), 107.
fuel consumption, IX, 790; XI-(1), 632, 691; XIV, 1113; XIV-(2), 3; XV-(2), 8; XVI-(1), 107, 115.
locomotive, and the speed diagram, A. K. Shurtleff, XIV-(2), 3.
locomotive drifting, XIV-(2), 3; XV-(2), 8, 27; XVI-(1), 108.
locomotive standing, XIV-(2), 3, 4, 5, 6; XV-(2), 8, 27; XVI-(1), 508.
locomotive working steam, XI-(1), 636, 1116; XIV-(2), 3, 8; XV-(2), 4, 8, 27; XVI-(1), 108.
movement of train behind tender, XVI-(1), 108.
proportion to horsepower hours or tons of work performed, XI-(1), 691; XVI-(1), 108, 115.
quality and quantity, effect on locomotive performance, IX, 790; XI-(1), 632, 709, 713; XIV-(2), 8; XV-(2), 6.
varying with rise and fall (see Rise and Fall, Fuel Consumption).

Economics—Continued

—Fuel (Various)
coal and gasoline compared as fuel for pumping stations, X-(1), 781.
for various types of pumps and engines, XVI, 705.

—Grades
balanced, for use of assistant engines, R. N. Begien, XII-(1), 330.
compensation in tunnels, XI-(2), 1068, 1071, 1073, 1086, 1088, 1095; XIV, 625.
example of unprofitable expenditure in reducing ruling gradient, XI-(1), 690.
followed by center of gravity of train, XV-(2), 7.
helper, V, 671, 701.
light, giving maximum benefit on lines of two or more tracks, IX, 775; XI-(1), 690; XVI-(1), 105, 112.
limiting effect of long, XI-(1), 647; XIV, 626, 628.
low speed on, XIV-(2), 10.
maximum and minimum speeds on momentum grades for summits and sags, III, 28.
maximum benefit from 0.3 per cent. to be secured on double track, VIII, 249; XI-(1), 690.
momentum, I, 31, 33; II, 21; III, 33; V, 673, 718.
objections to indiscriminate use of momentum grades, III, 22.
passing sidings and approaches, ruling gradient compensated for, XVI-(1), 105, 111.
reduction problems, C. P. Howard, XV-(2), 3.
reduction to 0.3 per cent., anticipated capacity of engines realized, VIII, 252.
ruling, I, 32; III, 18; V, 609, 697, 700, 717.
running a test train, VIII, 254; XV-(1), 17.

—Labor
equating values, XV, 590.
roadway, economics, XV, 398.

—Locomotives
rating, I, 34; II, 22, 25.
Southern Pacific Company, tonnage rating, II, 22, 25.
tonnage rating, II, 22; III, 17; V, 697, 711.
tractive power at various speeds, III, 28; V, 712.

—Maintenance and Operation
of equipment, V, 694.
of way, V, 694.
the several items to be considered in, II, 22.

Economics—Continued

—Masonry
cost, comparison between temporary and permanent structures, II, 73.
—of concrete, III, 307.
culvert, plain concrete arch, X-(2), 1345, 1348.
economic considerations, II, 67.
permanent work, II, 73.
relative, between stone and concrete under certain conditions, II, 79.

—Principles
formulas, III, 17; XVI-(1), 104.
fundamental, III, 17; VIII, 146; XVI-(1), 104.

—Railway Location
(see Comparisons.)

—Rail Wear
as affected by tonnage, XI-(1), 699.
laws of, XI-(1), 692-702.
on Northern Pacific Railway, XI-(1), 695.
—section machine, XI-(1), 704, 708.

—Speed
average, in motion between terminals compared, XIII, 1153.
curves or diagrams, XI-(2), 1316, 1319, 1320, 1327; XIV-(1), 1113; XIV-(2), 3, 8; XV-(2), 7; XVI-(1), 106, 112.
diagram and locomotive fuel consumption, A. K. Shurtleff, XIV-(2), 3.
economic and efficient, of freight trains, John D. Isaacs and E. E. Adams, XI-(2), 1328.
fast and slow freight service, comparative cost, W. B. Poland, IX, 795.
maximum, at full cut-off, IX, 790; XI-(1), 636, 646.
profiles showing, XI-(2), 1327; XIV-(2), 6; XV-(2), 7, 18; XVI-(1), 106, 112.
that may be maintained by given engine and train on a given grade, formula, XV-(2), 18.

—Ties
economy in labor and material, treated versus untreated, XV, 728; XVI, 522.
economy in white oak, XV, 744.
value, comparative, of different materials, using tie-plates, XV, 745.

Economics—Continued

—Track
economics of, XIV, 108, 1066; XV, 587, 1064; XVI, 716.
values, equating labor, XV, 590.

—Train Loading
relative economy of, IX, 798.

Elastic Limit
(see Physical Properties of Bridges; Rail, etc.)

Electric

—Accidents
to poles, arms, pins or insulators of aerial lines, XII-(1), 202.

—Bibliography
of electrolysis due to stray currents, XIII, 1001.
use of electricity as replacing steam on trunk lines and terminals, XII-(1), 140.

—Braid
table giving load and loading of hard and soft drawn copper wire, stranded and solid of different gage, XII-(1), 214.

—Cables
(see Signals.)

—Circuits
classes of construction, suggested division by voltage and by voltage and circuit, XII-(1), 203.
effect of creosoted ties on track, XIV, 75, 1046; XV, 73.

—Clearances
location of third-rail conductors and other clearances, XI-(1), 103; XII-(1), 152, 160, 166, 222; XIII, 510, 524, 525, 998; XIV, 987, 1007; XV, 610; XVI, 918.
overhead of electric light and power lines, XIII, 512, 522, 999; XIV, 988; XVI, 939, 948.
recommended, XII-(1), 153.
third rail, tables, XII-(1), 154; XIII, 524; XIV, 1007; XV, 615; XVI, 928, 929.

—Conductivity
aluminum wire, standard, table giving data, XII-(1), 214.
flexible electrical conductors, XII-(1), 126.
insulation resistance in megohms per mile at 60 degrees Fahrenheit, XIII, 70.
stranded electric conductors, XII-(1), 125.

Electric—Continued

—Control
manually operated, electrically controlled block system, table showing extent of use, VI, 532.

—Cradle
function of in overhead construction, XII-(1), 207.

—Crossings
of transmission line of high voltage, dangers from and precautions to be observed, XII-(1), 200.
overhead of electric light and power lines, XIII, 512, 522, 999; XIV, 988; XVI, 939, 948.
wires, size and material of, for overhead crossings, XII-(1), 209.

—Definitions
of terms, XII-(1), 152, 155, 163, 164; XIII, 510.

—Effect on Masonry
of electric currents, XIV, 837; XV, 567.

—Formulas
for catenary stresses, XII-(1), 215.

—Generator
and motor for electric interlocking, specifications for, X-(1), 124.

—Grounding
discussion on, XII-(1), 208.

—Historical
account of the organization of committee and development of its work, XII-(1), 135.

—Ice
and wind loads on wires in overhead construction, XII-(1), 206.

—Insulation
accidents to poles, arms, pins or insulators of aerial lines, XII-(1), 202.
desirable qualities, XII-(1), 210.
metal ties, VIII, 460; X-(1), 528, 530; XII-(1), 375, 377, 384, 399; XIII, 343, 352, 356, 357; XIV, 760; XV, 757, 761, 762.

—Interlocking
electrical, specifications for, X-(1), 113; XI-(1), 76.
electric tests of rubber insulation, X-(1), 152; XII-(1), 103, 108, 112.

Electric—Continued

—Light Lines
electric, overhead crossings of, specifications, XIII, 512.

—Lines
where occupied by city or interurban electric lines, II, 328.

—Loading
ice and wind loads on wires in overhead construction, XII-(1), 206.
of aluminum, XII-(1), 212.
of copper wire, XII-(1), 213, 214.
of steel wire, XII-(1), 212.

—Locomotive
power of electric, XIV, 633.

—Maintenance
organization for electrically operated sections of steam railroad, discussion, with two outline plans, XII-(1), 155, 162, 199.

—Megohms
resistance, per mile, X-(1), 153; XII-(1), 70.

—Pins (Insulator)
accidents to, XII-(1), 202.
type best suited for insulation of high voltage transmission lines, XII-(1), 210.

—Poles
accidents to, XII-(1), 202.
loading of, in overhead construction, discussion and formulas, XII-(1), 204.
preservative treatment, XII-(1), 211.

—Recommendations
on clearances, reasons, XII-(1), 153.

—Resistance
electrical, of treated ties, effect on track circuits, XII-(3), 429, 470.
of treated timber, J. T. Butterfield, XII-(3), 470.

—Shovels
electric, for tunnel excavation, XV, 391, 399.

—Specifications
overhead crossings of electric light and power lines, XIII, 512, 522, 999; XVI, 939, 948.

Electric—Continued

—Standards

for aluminum wire, XII-(1), 214.

—Stranding

for electrical work, X-(1), 156.
steel wire, XII-(1), 212.

—Tables

giving load, loading and other data of hard and soft drawn stranded and solid copper wire of different gage, XII-(1), 213.
of aluminum wire, XII-(1), 214.
on clearances, XII-(1), 154; XIII, 524; XIV, 1007; XV, 615; XVI, 928, 929.

—Tests

electric, of rubber insulation, X-(1), 152; XII-(1), 103, 108, 112.

—Third Rail

location of third rail conductors and other clearances, XI-(1), 103; XII-(1), 152, 160, 166, 222; XIII, 510, 524, 525, 998; XIV, 987, 1007; XV, 610; XVI, 918.

—Track Circuits

effect of creosoted ties on, XIV, 75, 1046; XV, 73.

—Treatment

electrical, for softening water on El Paso & Southwestern System, VIII, 623; IX, 113, 155.
plan of tank for system of electrically treating water, IX, 160.
preservative on poles and crossarms, XII-(1), 211.

—Trunking

standard wood, for electric interlocking, X-(1), 139, 141.

—Voltage

class of construction, suggested division by voltage and by voltage and circuit, XII-(1), 203.
tests of rubber covered wire, X-(1), 156.

—Weatherproofing

covering of weatherproofed wires, XII-(1), 115, 118, 120.

—Wind

loads on wires, in overhead construction, XII-(1), 202, 206.

Electric—Continued

—Wire

aluminum, XII-(1), 214.
copper, XII-(1), 213.
failures of span wire in overhead construction, XII-(1), 202.
steel, XII-(1), 212.

Electrolysis

bibliography, XII-(1), 140; XIV, 1001.
effect of electric currents on concrete, XIV, 837; XV, 567.
its effect on wire, VII, 466.
nature, cause and effect, and prevention; study of losses and attempts to prevent, XIV, 988, 1008; XV, 611, 1069; XVI, 922.

Elevation

(see Rail; Track.)

Elevator

for handling grain, IV, 369; V, 214.
for use in freight houses, XV-(2), 376.
inclined, for use at piers, XIV, 952.

Eliminating Grades

(see Grades; Crossings; Track Elevation.)

Elongation

(see Rail.)

Elsterite

(see Roof Covering.)

Embankment

(see Excavation; Roadway; Cross-Section.)

—Clearing for

buildings, IV, 21; XI-(2), 1064; XVI, 567.
height of stumps, IV, 21, 85.
timber, IV, 21, 33, 90.
unit of measurement, IV, 21, 32, 33, 39, 94; VI, 123; XI-(2), 1064.

—Consolidating

outer ridge for holding rainwater, IV, 14, 97, 115.

—Core

central, by team work, III, 31; VIII, 305, 348.

—Covering

of embankment, III, 15; IX, 606.

Embankment—Continued

—Cribbing
sandbags, etc., II, 20; X-(2), 1052, 1066.

—Cutting Down
payment for, IV, 114; VI, 144, 160, 164.

—Diagram (Mass)
mass diagram, VII, 395.

—Drainage
blind drains, II, 19; X-(2), 1059, 1060.
preliminary, II, 15.
(see Drainage.)

—Filling
by truss span and movable tower, III, 32.
during construction, X-(2), 1035, 1073.
height of fills to be built from trestles, VIII, 305, 348.
trestle, III, 30; IV, 13, 114.

—Grubbing
for light fills, II, 15; IV, 33.
unit of measurement, IV, 21, 32, 33, 39, 94; VI, 123; XI-(2), 1064.

—Hydraulic
(see Methods.)

—Payment
grading, price and measurement, IV, 25.
(see Contract.)

—Protection
anchor riprap, XII-(3), 532.
lock joint pipe pile protection, XI-(1), 206.
mat revetment for river protection, X-(2), 1114-1117.
planting of willows, I, 29; II, 19.
reinforced concrete mattress, XII-(3), 540.
sandbags, X-(2), 1075.
types of mechanical protection of piles, XI-(1), 201.
water-softened embankment, X-(2), 1063.

—Raising
track, heights of lifts, III, 31; VIII, 305, 348.

—Riprap
for use on embankments, II, 19; X-(2), 921, 989, 1031, 1048, 1060, 1087, 1105; XII-(3), 530, 532, 540.

Embankment—Continued

—Shrinkage
horizontal III, 32, 46; VIII, 307, 349; IX, 608.

—Slopes
curved, II, 16.
stability of angle, III, 15, 34, 44; IV, 123, 125, 145.

—Team Work
base put in by, III, 32.
central core by, III, 31; VIII, 305, 348.
light and short haul work done by, IX, 607, 609, 610, 645.

—Trestles
filling, III, 30; IV, 13, 114.
(see Trestles.)

—Washout
undermining and washing of bank from about culverts, X-(2), 983, 986, 989, 1032, 1077.
(see Protection.)

—Widths
of cuts, excluding ditches same as on embankments, III, 42; VI, 122.

Emulsion
specifications for zinc-creosote treatment, XI-(2), 741.

Engine
(see Locomotive; Yards.)

—District
length of, XIII, 1153; XV-(2), 9; XVI, 105, 111.

—Helper
(see Grades; Locomotive.)

—House
(see Buildings.)

—Repairs
cost of increased by dirty ballast, I, 88.

—Terminals
requirements, with typical plan, XIII, 91, 947.

—Thrust
of different types against rail, X-(2), 1440.

Engine—Continued

—Yard

switch engine service in yards and terminals, how arranged and how records are kept, IV, 350.

Engineer

authority of, V, 588; VI, 135, 144, 162; XVI, 572.
decision shall be final, clause, X-(2), 1198.
defined, X-(2), 1276.
province of, limitations as to, XIV, 1112, 1113, 1116, 1117.

Equating Values

of track, XV, 590; XVI, 736.
(see Economics; Track.)

Equipment

maximum now in use, XVI, 676.
(see Various Kinds.)

—Maintenance

of equipment, V, 694.

—Weight

average per axle of engines and cars, comparison, XIV, 582.

Erection

(see Bridges.)

Estimate

final, XIII, 1159.
for water service, XI-(2), 1124.
form of for expenditure, VIII, 116; IX, 674.
form for bridges, trestles, culverts, etc., XI-(2), 1121; XII-(3), 415, 418, 420.
form for track construction, X-(2), 866.

Etching

(see Rail.)

Ether

anthracene oil in, XI-(2), 812, 816.
creosote in, XI-(2), 812.

Evaporation

(see Creosote; Locomotive, etc.)

Excavation

(see also Embankment; Cross-Section.)

Excavation—Continued

—Borrow Pit

excavation, borrow pits, IV, 25; XVI, 568.
land for, purchased at whose expense, IV, 25, 34, 99.

—Classification

of excavation, IV, 22, 32, 35, 44; V, 687, 688, 719; IV, 123; XVI, 567, 1075.
of soils, XVI, 579, 1074.

—Clearing

in advance of grading, IV, 21.
removal of buildings, IV, 21; XI-(2), 1064; XVI, 567.
timber reserved, cut and piled, payment for, IV, 21, 33, 90.

—Cut Embankment

payment for, IV, 114; VI, 144, 160, 164.

—Cuts

with wide base and steep slopes, II, 16.

—Diagram (Mass)

mass diagram, VII, 395.

—Explosives

breaking up lower strata of slides with explosives, X-(2), 1090.
first use of dynamite, IV, 15.

—Haul

(see Haul.)

—Loose Rock

removal by steam shovel, classification for loose rock, VI, 146.

—Measurement

price and (see Grading.)

—Methods

running a gullet through first, IV, 14.
various devices for excavating, hauling and dumping, VIII, 306, 348.
well-defined plan for heavy excavation before starting work, IX, 591, 609, 638.

—Moving

earthwork to be handled by machinery, IX, 591, 609, 638.
first use of grading or road machines, IV, 15.

Excavation—Continued

—Payment for

excavation in water, IV, 114.
extra work, VI, 135, 144, 160, 164; XI-(20), 1064; XVI, 571, 1075.
for rock cuts below sub-grade, IV, 22, 100; VI, 142, 144, 171; XVI, 567.

—Rock

cuts below sub-grade, payment for, IV, 22, 100; VI, 135, 144, 160, 164; XI-(2), 1064; XVI, 571, 1075.
removal of by steam shovel, classification for loose rock, VI, 146.

—Scrapers

early use of drag, IV, 12.
early use of wheel, IV, 15.

—Team Work

base of embankments put in by, III, 32.
central core by, III, 31; VIII, 305, 348.
light and short haul work done by, IX, 607, 609, 610, 646.

—Tunnel

(see Tunnels.)

—Wet

excavation in water, payment for, IV, 114.

Expansion

(see Rail; Track, etc.)

Expenditure (Authority)

form for, VIII, 118, 120, 138.

Explosives

breaking up lower strata of slides with explosives, X-(2), 1090.
first use of dynamite, IV, 15.
first use of nitro-glycerine, IV, 15.

Extensometers

impact tests made with, VI, 255.
plan of bridge extensometer, XII-(3), 19.

Extra Work

how arranged for, XIII, 1071.
payment therefor, VI, 135, 144, 160, 164; XI-(2), 1064; XVI, 571, 1075.

Eye Bars
unequal pull of found in during impact tests, XII-(3), 52.

F

Fabrication
(see Bridges.)

Facing Point Switch
(see Switch.)

Fall and Rise
(see Economics.)

Fans
(see Tunnels.)

Farm Crossing
(see Crossing.)

Fastenings
(see Track; Ties, etc.)

Felts
(see Buildings; Roof Covering.)

Fence
abstract of state laws regarding, V, 403.
analysis of types most useful for railroad purposes, V, 380.
instructions regarding, XIV, 68, 1037.
material needed for wire and board, V, 391.
snow, X-(1), 887, 888.
standard, V, 398. 400.

—Board
material needed for, V, 391.

—Historical
brief history of development of present-day fence, V, 380.

—Posts
comparative cost of steel and wood, XVI, 497.
concrete, types, manufacture, tests and use, X-(2), 898, 916; XII-(3), 614; XIV, 808, 1172.
steel, cost and estimated life, XIV, 794.
tests on twenty concrete posts, XIV, 812.
use of in foreign countries, XI-(2), 1241.
wooden, XIV, 792.

Fence—Continued

—Snow
care of, I, 151.
permanent and portable, various types, substitutes described, advantages and disadvantages shown, X-(2), 881; XI-(2), 1239; XVI, 441.
sheds, X-(2), 886, 893.

—Specifications
for standard right-of-way, VII, 451; XI-(2), 1231; XVI, 436.

—State Laws
abstract regarding, V, 403.

—Wing
custom of railroads in whitewashing wing fences to stock guards, XVI, 496.

—Wire
means of securing quality to resist corrosion and render service, XI-(2), 1235; XII-(3), 614; XIII, 902; XIV, 826.
sizes, weights, and other data of those commonly used in fencing, V, 392.
table showing barbed wire needed for fences, V, 391.

Fenders
piles, II, 157.
(see Culverts; Wooden Bridges and Trestles, etc.)

Ferro-Manganese
(see Rail.)

Ferry Transfer
of New Haven Railroad at Harlem River; history of its inception and development, V, 206.

Filing Case
plan of, III, 366.

Fillers
(see Track.)

Fills
(see Embankment.)

Filtering (Water)
cost of plant and of doing the work, II, 232.

Final Estimate
liens and final estimate, XIII, 1159.

Finishing Temperature
(see Rail.)

Fir
rules for classification and grading Douglas fir, XII-(3), 548.
tests of red fir timbers, cross-bending, VI, 107.
(see Grading of Lumber.)

Fire
(see Conservation of Natural Resources.)

—Prevention
Canadian regulations for preventing setting fires by locomotives, XIV, 136.
laws to prevent forest fires, XII-(3), 631.
practice of various railroads as to gravel, broken stone, galvanized iron, paint, etc., XIV, 690, 694.

—Proofing
concrete as a fireproofing material, XI-(2), 1003.
reinforced concrete trestle, as protection against fire losses XII-(1), 582.

—Protection
fire-resisting qualities of roofing tested, XII-(1), 617, 622.
—in roof covering important, XII-(1), 610.
in freight houses, III, 262, 265; XVI, 755.
methods of protecting wooden bridges from fire, XIV, 690.

Fissure
(see Rail.)

Flagmen
watchmen, flagmen and operators, VI, 144, 155, 158; XVI, 571.

Flangeway
at highway crossings, width of and accidents from insufficient, X-(2), 912.
filler for, I, 150; II, 283.
interference of wheels of cars with, X-(1), 399.
some investigations of use at street crossings in paved streets, XIII, 902.
track construction and flangeways, XVI, 443, 1043.

Flashing Angles
flashings and counter flashings of different types, XIII, 891-896.
method of waterproofing by use of, XV, 534.

Flexure

equations of flexure of reinforced concrete beams, V, 632.

Floats

(see Car.)

Flood

ballast for track below high water, X-(2), 921, 1105; XVI, 573.
main track to be above, X-(2), 921, 1105; XVI, 573.
observing or marking height of flood or high water, VIII, 35.

Floor

division of floor area in a passenger station, XVI, 739.
effect of differences in impact on stringers and floor beams due to design, XII-(3), 36.
extra strong when electric trucks are used, XIV, 1084.
floor beams, stresses due to deformation of chords, XV, 486.
—in pin-connected and riveted trusses, lateral bending in, XII-(3), 53.
flooring, Douglas fir, XII-(3), 558.
—cypress, XIII, 881.
—Northern pine, XII-(3), 573.
—Southern yellow pine, XII-(3), 589.
—standard sizes, XII-(3), 563, 598.
formula for determining distribution of load on concrete floor slabs, XI-(2), 1007.
foundations for shop floors, XVI, 759.
preparation of foundation and laying freight house floors, types, XIV, 879.
shop floors, requirements and types described, XVI, 757.
solid, for bridges, method of waterproofing, XV, 531.
waterproofing solid bridge floors on Pennsylvania Lines, XII-(1), 530; XIII, 471.
wood block for freight house floors, advantages and recommended treatment, XIV, 880.

Flow

(see Rail; Water Service.)

Foaming

(see Boilers.)

Forests

(see Conservation.)

Foremen

(see Bridge; Track, etc.)

Forks

(see Ballast.)

Forms (Concrete)

for retaining concrete, III, 322; V, 611, 653; XI-(2), 1002.
lumber should be sized, V, 653.

Forms (Reports)

(see Accounts; Bridges, etc.)

Formulas

(see Abutments; Ballast; Concrete, etc.)

Foundations

for interlocking plant, description, sizes, space required, etc., X-(1), 106.
for water stations, X-(1), 746.
—cost of, X-(1), 793.
for water tanks, III, 163.

Framing Timbers

and boring holes before treatment, XII-(3), 425, 445, 477.
treatment of surfaces exposed by framing after treatment, XII-(3), 478.

Freezing

laying concrete under water and in freezing weather, II, 82, 101; XI-(2), 1001; XIII, 487, 994.
reinforced concrete laid in freezing weather, V, 665.
resistance of concrete to frost and ice, II, 72, 91.

Freight

—Handling
as practiced on English railways, baggage and freight, XV, 122.
at river and rail terminal, XII-(1), 243; XVI, 963.
fast and slow freight service, comparative cost, W. B. Poland, IX, 795.
formula for determining cost of trucking in freight houses by different methods, XVI-(2), 234.
freight handling systems, X-(1), 273, 275.
freight houses using mechanical appliances for freight handling, XIV, 940-947.
mechanical appliances for on export piers, IV, 363; IX, 535; XII-(1), 246; XIV, 954; XV, 102, 116.

Freight—Continued

—Handling

—installed in warehouses, IX, 565, 569; X-(1), 257; XI-(2), 1266; XII-(1), 236; XIV, 938; XV, 102, 118; XVI, 962.
opinions of six railroad officials and several installations noted and described, X-(1), 257.
platforms used at freight houses in nine large cities, III, 269.
several methods of handling freight by machinery, XI-(2), 1266.
telpherage freight handling system, X-(1), 270.

—Houses

(see Buildings.)

—Platforms

used at freight houses in nine large cities, III, 269.

—Service

fast and slow freight service, comparative cost, W. B. Poland, IX, 795.
economic and efficient speed of freight trains, XI-(2), 1328.

—Terminal

comparison of investment per car and interest charges per ton of single and double deck freight houses for different land values, XV-(2), 383.
driveways and teamways at, III, 274, 275, 276, 278, 279.

—Yards

(see Yards.)

Friction

(see Resistance; Water Service.)

Frogs

formulas and tables, IX, 424; X-(1), 405.
length recommended, XIII, 373, 965.
manganese construction, XII-(1), 410; XVI, 718, 1140.
numbers recommended, XIII, 373, 965.
plans, VIII, 539; XIII, 379-385.
properties of, X-(1), 407.
rail-bound, dimensions, XVI, 726.
recommended construction, VIII, 536, 594; IX, 388, 417.
rules for use, I, 149.
specifications for, X-(1), 408; XI-(2), 936; XII-(1), 403; XIII, 371, 375, 965; XIV, 733, 1136.
standard blocking, VI, 757; XVI, 729.
(see Switch; Turnout.)

Frostproofing
(see Water Service.)

Fuels
(see Coal; Locomotive; Water Service.)

—Comparisons of
coal and gasoline compared as fuel for pumping stations, X-(1), 781.
coal and oil as fuel compared, XIII, 437.
cost of fuel for various types of pumps and engines, XVI, 705.
petroleum as a locomotive fuel, XIII, 438.

Fungi
experiments in the rotting pit at Stendal, Germany, XI-(2), 812, 816.
which live on structural timber, XI-(2), 818.

Furnace Slag
(see Ballast; Roadway.)

G

Gag
(see Rail.)

Gage (Gauge)
affected by wheel gage, I, 153; VIII, 597; X-(1), 398.
for steam shovel track, III, 30; VIII, 302, 346.
instructions concerning, XIV, 66, 1028, 1044.
maintenance of, I, 147; II, 271; III, 59; V, 533-543; VII, 654; XI-(2), 934; XII-(1), 402; XVI, 732.
table showing required gage for given wheel base on different curve, IX, 394-397.
track, importance of, II, 272.
—best type of, II, 272.
wide, due to worn rail, X, 398; XI-(2), 935.
widening on curves, I, 147; II, 273; III, 59; V, 534; IX, 389-422; XVI, 733.
—formula, II, 276.

Galvanize
(see Roof Covering; Wire.)

Gas
(see Natural Gas.)

Gasoline

coal and gasoline compared as fuel for pumping stations, X-(1), 781.
engine for electric interlocking, specifications for, X-(1), 123.
fuel for various types of pumps and engines, XVI, 705.
steam, gasoline and air pumping, discussion, XVI, 695.
tests of, for water supply, X-(1), 770.

Gates

for farm crossings, V, 384, 400.
for highway crossings, types, advantages and cost, II, 328.
for right-of-way fences, types, widths and heights, and other data, VIII, 526, 529, 531; X-(2), 876, 910; XII-(2), 1234; XVI, 440.
hinged metal, XII-(2), 1234.
plans, V, 398, 400.
—farm, VIII, 529-531.

Gear Teeth

formula for strength of cut gear teeth, X-(2), 339.

Geared Locomotive

curves of short radius and on heavy grades operated by, XVI, 968.

Generator

and motor for electric interlocking, specifications for, X-(1), 124.

Gilsonite

(see Roof Covering.)

Girders

design for reinforced concrete, V, 604.
hip vertical in riveted truss, unequal stresses found in, XII-(3), 53.
maximum percentages plate girder deflections, XII-(3), 283.
solid floors of plate girder bridges, method of waterproofing, XV, 531.
spacing of stiffeners of, VII, 211.

Giussani Process

creosoted, life of, XVI, 879.
life of, XVI, 876, 879.
zinc-creosoted, life of, XVI, 879.

Gordon Formula

for unit strains, VI, 205.

Government Requirements
by Federal and State Commissions, XV, 928; XVI, 786.
Interstate Commerce Commission, forms for reports, V, 282.
(see also State Laws.)

Grade
formula for computation of rate per cent. of helper grades, XII-(1), 333.
formula for grade resistance in engine rating, XIII, 1155.
—for momentum grades, XIII, 1157.
(see Economics.)

—Balanced
for use of assistant engines, R. N. Begien, XII-(1), 330.

—Compensated
for curves, II, 21; VIII, 150; IX, 772; XI-(1), 655, 657, 664, 666, 693, 718; XIV, 589, 620, 1112, 1120, 1127; XVI-(1), 113.
in tunnels, XI-(2), 1068, 1071, 1073, 1086, 1088, 1095; XIV, 625.
maximum, for given maintained speed, engine and loading formula, XIV-(2), 11.

—Crossings
bibliography on, in American cities, IX, 613; XVI-(2), 188.
elimination of in Chicago, I, 169.
elimination of, IX, 609, 610; X-(2), 926.
grade crossing elimination organization, XV-(2), 110.
state laws regarding, X-(2), 919, 926, 932.
states providing for division of expense, X-(2), 926.
traffic counts in various cities at grade crossings, XVI-(2), 155-159.
(see also Elimination; Crossings.)

—Development
of distance to reduce ruling gradient, XI-(1), 690; XVI-(1), 105.

—Elimination
organization for, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.
plan, map and profile of grade elimination territory at Cleveland, Ohio, on the New York, Chicago & St. Louis Railroad, XV-(2), 105.
plant used at Cleveland on the New York, Chicago & St. Louis Railroad, XV-(2), 113.
tabulation of data regarding track elevation and depression work inside cities, IX, 592-601.
(see Crossings.)

Grade—Continued

—Equivalent

unequal traffic, V, 672.

—Helper

computation of rate per cent. of helper grades, XII-(1), 333.
engine, V, 701; XII-(1), 330.
grades, V, 671, 701.

—Improvement

(see Elimination; Reduction.)

—Limiting

effect of long, XI-(1), 647; XIV, 626, 628.

—Maximum

and minimum speeds for summits and sags, III, 28; XIII, 1157; XV-(1), 106, 113.
objections to indiscriminate use, III, 22; XIV, 627.
preferred on grade revision rather than new work, VIII, 253, 254

—Momentum

formula, XIII, 1157.
grades, I, 31, 33; II, 21; III, 22; V, 673, 718.
maximum and minimum speeds for summits and sags, III, 28.
objections to indiscriminate use, III, 22.

—Profile

value of keeping to original, correction of, XIV, 619, 626, 1127.
(see Profile.)

—Reduction

complete location before starting work, IX, 608, 610.
electrical conduits across bridges, IX, 602.
improvement in grade and alinement, I, 30; II, 20; III, 16, 29.
municipal assistance. IX, 602.
of gradient, and elimination of distance, curvature, and rise and fall, on Union Pacific Railroad, J. B. Berry, V, 689.
organization for grade and curve improvement work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.
outside cities, III, 29; IX, 602, 603, 610.
problems, C. P. Howard, XV-(2), 3.
work, III, 29; IX, 591, 603; XVI, 572.

—Resistance

(see Resistance.)

Grade—Continued

—Revision

tables used in connection with Union Pacific line revision studies, V, 690-718.

use of time curves or diagrams for determining economical gradient, IX, 779; XI-(2), 1320.

—Ruling

compensated for passing sidings and approaches, XVI-(1), 105, 111.

development of distance to reduce ruling gradient, XI-(1), 690; XVI-(1), 105.

gradient, I, 32; III, 18; V, 609, 697, 700, 717; VIII, 146, 249, 250, 251, 252; IX, 776; XI-(1), 689; XV-(2), 3; XVI-(1), 111.

limiting effect of long, XI-(1), 647; XIV, 626, 628.

—Tunnel

ascending grades in same direction as prevailing winds, XV, 391.

compensation in, XI-(2), 1068, 1071, 1073, 1086, 1088, 1095; XIV, 625.

—Velocity

grades (see Momentum.)

—Virtual

grades, I, 34; II, 21; III, 18.

—Yard

gradients in gravity yards, I, 23; VI, 578; VII, 138, 157, 180; IX, 516, 524, 545; XIV, 937.

Grading

(see Embankment; Excavation; Lumber.)

Graduation

(now called Roadway.)

Grahamite

(see Buildings; Roof Covering.)

Granite Blocks

supporting rails, early construction, IV, 9.

—Disintegrated

(see Ballast.)

Granular Structure
(see Rail.)

Grass
removal of, I, 150; II, 293.

Grate Area
(see Locomotive.)

Gravel
(see Ballast; Roof Covering.)

—Beach
faults of from lake beach, I, 107.

—Pit
opening a pit, X-(1), 681.
operating gravel, X-(1), 681, 695.
percentage of rock, gravel, sand and dust in 35 pits. XIII, 100.
pitmen, number of, VIII, 302, 346.
typical for washing and digging, X-(1), 681.
working methods, X-(1), 695.

—River
from river beds, III, 140, 141.

—Screened
preparation, X-(1), 678.
washed and crushed, I, 96; VI, 737; X-(1), 723; XIII, 103.

—Washed
plant for, X-(1), 685, 690; XIII, 103.
screenings, washing and crushing gravel for ballast, I, 96; VI, 737; X-(1), 723; XIII, 103.

Gravity Yard
(see Yards.)

Gridiron
(see Slides; Roadway.)

Grooved Roofing
(see Buildings; Roofing.)

Grout
(see Cement.)

Grubbing
for light fills, II, 15; IV, 33.
unit of measurement for clearing and, IV, 32, 33, 39, 94; VI, 123.
(see Embankment; Excavation.)

Guard Rail

dapping of, XVI, 1181.
drawings and plans, XIV, 658.
effectiveness of, experience of railways, XIV, 679, 684.
ends of, III, 298; XV, 403, 1036.
faced with iron, II, 140.
fastenings for, XIV, 681, 682; XV, 403, 1036.
filler for flangeway, I, 150; II, 283.
height of, XIV, 653, 1142.
inner, III, 298; VI, 44, 48; XIV, 652; XV, 402.
instructions concerning, XIV, 67, 1035.
position, XIV, 653.
practice of roads in use of guard rails and guard timbers on bridges, XIV, 654.
recommended, XIV, 652, 1136; XV, 403, 1036.
rerailing devices with, on various railways, XIV, 677.
standard gage, plan of, IX, 392.

Gullet

running a gullet through excavation first, IV, 14.
(see Embankment; Excavation.)

Gumbo

(see Burnt Clay Ballast.)

Gutters

(see Buildings; Roof Covering.)

H

Hand Cars

rules governing use, XIV, 69, 1042.
types, II, 289; III, 62.

Haul

diagram showing free haul and overhaul, IV, 125.
formulas for computing average haul and overhaul, VII, 374-413.
light and short haul work done by teams, IX, 607, 609, 610, 646.
mass diagram, VII, 395.
overhaul, IV, 115, 119; VI, 151; VII, 344, 346, 353, 357, 428, 443; VIII, 313; XVI, 569, 1073, 1079.
payment for tunnel excavation haul, IV, 35; XVI, 570.
tabulation as to preference for computing and paying for overhaul, VII, 430.
various devices for excavating, hauling and dumping, VIII, 306, 348.

Head (Water)
diagram showing loss of head in water columns, XI-(2), 1191, 1217.
loss of head in water columns, XI-(2), 1187.
loss of in feet in new straight pipe, tees and elbows, diagrams, X-(2), 1216, 1217.
pressure from head of water, effect of valve movement on, XI-(2), 1186-1213.
table of flow of heads and discharges, XI-(2), 1180.

—Velocity
velocity head formula, III, 19, 20, 26, 27.

Headings
(see Tunnels.)

Heat
formula for hourly evaporation for ratios of heating surface to grate area; XI-(1), 635.
(see Buildings; Locomotive; Subways, etc.)

Helper Engine
(see Locomotive.)

—Grades
(see Grades.)

Hemlock
grading rules for, XVI, 907.
specifications for, XII-(3), 575.

High Water
main track to be above, X-(2), 921, 1105; XVI, 573.
necessity for observing and marking, VIII, 35.
track below, ballast for, X-(2), 921, 1105; XVI, 573.

Highway Crossings
(see Crossings.)

Holbrook Spiral
(see Curves.)

Hoops
for water tanks; widths, thickness, spacing, shape and style, III, 178; X-(1), 818; XI-(2), 1146; XII-(3), 392.

Horse Power
(see Locomotive.)

Hump Yard
(see Yards.)

I

Ice
and wind loads on wires in overhead construction, XII-(1), 206.
description of ice storage house, natural ice, elevator, crushing, plant, and icing platform, V, 174.
methods of preventing drifts of snow and ice, X-(2), 881; XI-(2), 1239.
plan of icing plant, Lake Erie & Western Railroad, V, 174, 176.
resistance of concrete to, II, 72, 91.

Icing Cars
icing platform, V, 174.

Impact
(see Bridges; Locomotive; Roadway, etc.)

Improvements
form of requisition for improvements, VII, 288.
(see Bridges; Grade; Track, etc.)

Inclines
(see Coal Piers.)

Incrusting
(see Boilers.)

Indications
(see Signals.)

Industrial Tracks
form of agreement for sidetrack to industries, III, 398, 418.
industrial district yard, III, 266.
industrial tracks, seven per cent. grade, sharp curves worked by geared engines, XVI, 968.
plan of industrial district yard, III, 268.
which may be worked by geared engines, XV, 968.

Ingots
a method of revealing segregation in ingots, XIV, 487.
analysis of test ingots, XIII, 667.
bibliography on production of sound ingots, XIV, 446.
cavities in, XIII, 753; XIV, 401.
chemical composition of ingot does not insure good wearing rail, VI, 178, 179.

Ingots—Continued

crack in ingots produces seams in rails, XV, 315.
defective rail rolled from top of ingot, VI, 183; VII, 549.
defective steel in top of, VI, 183; XIV, 276.
drop test to determine effect of rail on size of ingot, XIII, 690.
effect of piping, cavities and porous spots on the finished rail, XIV, 178, 401.
influence of aluminum on Bessemer ingots and rails, XV, 337.
influence of silicon on Open-Hearth ingots, XIV, 507.
influence of titanium on Bessemer ingots, XIV, 219.
ingot making problem, XII-(2), 385.
method of producing sound, XIV, 178, 289, 449, 501.
methods of revealing segregation in, XIV, 487.
pipeless, XIV, 289.
position in ingot of rails which failed, XI-(1), 304-307, 375-384; XII-(2), 105-134.
seams developed from cracks in ingot, XV, 315.
segregation influenced by fire clay on ingot, XII-(2), 494.
size of ingot influencing properties, XIII, 655.
testing each, XIV, 177.
tests of ingots allowed to cool in a vertical position, XI-(1), 522.
tests of at Watertown Arsenal, XIII, 753.
test piece from top of ingot, VI, 183.

Inspection

(see Bridges; Rail, etc.)

Instructions

(see Bridges; Rail, etc.)

Insulation

(see Electric; Signals; Track.)

Insurance

clause in form recommended by Committee on Buildings, compared with like clause in use by various railroads, X-(2), 1279; XIV, 1149.
value of curvature, V, 728.

Interchange

(see Yards.)

Interstate Commerce Commission

reports required by, XV, 928; XVI, 786.
report of track data to, V, 282.

Interlocking
(see Signals.)

Iron
corrosion tests on, XV, 695; XVI, 713.
iron and steel papers, A. S. M. E., II, 196.
protection against corrosion, XV, 618.
resources of the United States, XVI, 998-1001.
specifications for cast-iron and steel castings, analytically compared, VI, 269.
specifications for castings of grey iron, X-(1), 164.
specifications for malleable iron castings, X-(1), 166.

Irrigation
slides caused by, X-(2), 1039.

J

Joint Bars
joints, XI-(1), 240; XV, 156.
method of waterproofing expansion, XV, 535.
specifications for materials in, XVI, 154, 403.
(see Track.)

—Masonry
method of waterproofing by use of flashing angles, XV, 534.
reinforcement joints in tension, XI-(2), 1002.

—Rail
four- and six-hole, V, 516.
joints, I, 150; II, 281.
picking up low, V, 533; VI, 757.
practice regarding drilling of, V, 518.
replies from railroads giving information regarding rail sections and splice bars, XV, 336.
requirement of a standard, VI, 747; VII, 655.
result of tests of rivcted, VI, 284, 395.
tie-plates, joints and rails in use on German railways, XI-(2), 1346-1377.

—Riveted
slip of plates in riveted, VI, 401.
tests of, VI, 374.

Joists
specifications for common, Douglas fir, XII-(3), 562.
—Northern pine, XII-(3), 575.
—Southern yellow pine, XII-(3), 596.
standard sizes, XII-(3), 563, 597, 599.

Journal Load
permissible load on pivots and journals, XV-(2), 340.

Juniper
treated and untreated, XVI, 860.

K

Kansas City Station
plan of Kansas City Union Station layout, XVI, 960.

Kerite
as a wire covering, X-(1), 158.

Knots
classification of in hemlock, XVI, 907.
—cypress, XIII, 875.
—Douglas fir, XII-(3), 548.
—Northern pine, XII-(3), 565.
—oak timber, XII-(3), 602.
—Southern yellow pine, XII-(3), 578.
table showing strength of timbers and effect of knots, VIII, 423-429.

Kutter's Formula
Chezy and Kutter's formula, X-(2), 980, 981.

Kyanizing
treatment, X-(1), 618.

L

Labor
accounts, classification of, II, 322.
reports, recommendations for time books, with forms, II, 316; III, 383.
(see Economics; Signals; Track, etc.)

Laboratory
(see Rail; Tests.)

Lag Screws
use of, XVI, 896.

Lamination
(see Rail.)

Lath
byrkit, Southern yellow pine, XII-(3), 598.
Douglas fir, XII-(3), 564.

Laws (State)
(see Crossings; Signs, etc.)

Lead
(see Roof Covering; Cable.)

Lead
(see Switch; Track.)

Leases
record of, book for keeping, what it should show, with suggested forms, II, 321, 325; VI, 654.

LeChatelier Apparatus
specific gravity apparatus, VI, 719.
(see Specific Gravity; Cement.)

Lenses
signal roundels, lenses and glass slides, X-(1), 167.
specifications for, X-(1), 169.

Liens
and final estimate, XIII, 1159.
how treated, XIII, 1068.

Lighterage
description of open and covered, with recommendations, IV, 357, 372.
plan of open and covered, IV, 358, 360.

Lighting (Buildings)
coaling stations, III, 149; VIII, 258.
freight houses, III, 262-265.
warehouses on piers, by windows and artificial, IV, 359.

—Crossings
need of lights at highways, etc., II, 328.

—Yards
recommendations, IX, 541.
the problem stated, IX, 528.

Lime
formula for determining soda ash and lime for water treatment, VI, 618.
space needed in reservoirs for reacting soda ash and lime, VIII, 618.

Limestone
comparison between limestone and trap rock for ballast, X, 716.

Line
(see Alinement; Electric.)

Lining
(see Tunnels.)

Live Load
(see Loading.)

Live Stock
table showing live stock traffic on different divisions of 87 railroads, VII, 332.

Loading
breaking load on base of rail, XIV, 327.
compression curve and tie-plate, XI-(2), 830.
transitory depression of track under the moving locomotive and cars, XIV, 569.
(see Axle; Ballast; Bridges; Cooper's; Electric, etc.)

Located Line
definition of, XVI-(1), 104.

Location

—Economic Value
formula for economic value of a locomotive, XVI, 104.
(see Economics.)

—Historical
historical sketch on railway location, V, 667.

—Signal
location of, on ruling gradient, VIII, 253, 254.
masts, IX, 42.
standard, of telegraph block signals, VII, 485.

—Yard
or cluster of yards, some considerations governing, II, 40.

Lock Joint Pipe
plan of lock joint pipe pile protection, XI-(1), 206.

Locomotive
(see also Engine.)

Locomotive—Continued

—Balanced

vibration of bridges under, XII-(3), 27, 30.

—Boilers

(see Boilers.)

—Consolidation

velocity, distance and time with heavy consolidation locomotive, XI-(2), 1325-1327.

—Counterbalancing

diagram giving comparison between cylinder tractive power and drawbar pull, XI-(1), 670-674.
horsepower varying with speed, IX, 778.
locomotive, XIV-(1), 1109.

—Drawbar Pull

actual, at various speeds, XI-(1), 645.
adhesion, XI-(1), 647, 715; XIV-(1), 629.
comparison between cylinder tractive power and drawbar pull, XI-(1), 670-674.
mean power at drawbar of engine on level grade, mean resistance and differences, IX, 780.

—Driver Flange

power of locomotive, actual drawbar pull at various speeds, XI-(1), 645.
(see Flangeway.)

—Driving Wheels

size of cylinders and drivers, XI-(1), 645.

—Economics

actual drawbar pull of locomotive at various speeds, XI-(1), 645.
adjustment per car, XI-(1), 650, 651, 652, 653, 663, 687; XII-(1), 331; XIV, 618, 619, 630, 639.
and ratios of heating surface to grate area, XI-(1), 634, 635.
cost of helper engine mile, V, 702.
drawbar pull available on level tangent, XI-(1), 646; XIII, 1153; XIV-(2), 10.
equated tonnage rating on Chicago, Burlington & Quincy Railroad, M. H. Wickhorst, XIII, 1151.
fuel consumption and speed diagram, A. K. Shurtleff,, XIV-(2), 3.
horsepower at various speeds, XI-(1), 646; XIV, 644.
locomotive counterbalance, XIV-(1), 1109.
—horsepower varying with speed, IX, 778.

Locomotive—Continued

—Economics

locomotive resistance, XI-(1), 643, 644; XIV, 647.
margin between rating and maximum tractive power, XIII, 1154; XIV, 613, 627, 1118, 1119.
mean effective pressure curves, XI-(1), 632, 676; XI-(2), 1315, 1323.
Mikado, Baltimore & Ohio, at different speeds and on different grades, XIV, 612, 633, 648, 649, 650.
nosing of locomotive, XIV-(1), 1109,'1130, 1134.
per cent. of cylinder tractive power at "M" velocity for various multiples thereof, XI-(1), 640, 646, 670; XIV, 645.
rating, I, 34; II, 22, 25; XI-(1), 649, 663, 666, 686; XI-(2), 1312, 1316, 1324; XIII, 1151; XIV, 599, 627, 631, 1116.
Southern Pacific Company, tonnage rating, II, 22, 25.
speed, coefficient for changing revolutions per minute to miles per hour, XI-(1), 638; XIV, 640, 643.
speed, maximum at full cut-off, IX, 790; XI-(1), 636, 646, 709; XIV-(2), 10.
steam per square foot heating surface for various qualities of coal and ratios of heating surfaces to grate area, XI-(1), 634, 635.
steam producing capacity, XI-(1), 632, 635, 646, 713.
superheated steam, XVI-(1), 109.
tonnage rating reductions for temperature, XI-(1), 654, 666.
tractive force at speed, XIII, 1157.
tractive power greatest at starting, XI-(1), 646.
weight of steam for one foot of stroke in cylinders of various diameters, XI-(1), 637, 638, 640, 642.

—Electric

power of, XIV, 633.

—Evaporation

diagram showing relation between evaporation and coal consumption per sq. ft. of heating surface, XV, 140.
hourly for ratios of heating surface to grate area, XI-(1), 635.
tests of locomotives, Southern Pacific Company, XIII, 440.

—Fuel Consumption

diagram showing fuel consumption and time lost due to rise and fall on ruling and minor gradients, XVI, 132.
diagram showing relation between evaporation and coal consumption per sq. ft. of heating surface, XV, 140.
firing up at engine houses, XIV-(2), 4, 5, 6; XV-(2), 27.
foot-pounds of work performed as a measure of, XI-(1), 691; XVI-(1), 108.
for movement of locomotive alone, XVI-(1), 107.

Locomotive—Continued

—Fuel Consumption
for movement of train behind tender, XVI-(1), 108.
locomotive and the speed diagram, A. K. Shurtleff, XIV-(2), 3.
locomotive drifting, XIV-(2), 3; XV-(2), 8, 27; XVI-(1), 108.
locomotive standing, XIV-(2), 3, 4, 5, 6; XV-(2), 8, 27; XVI-(1), 508.
of locomotives, IX, 790; XI-(1), 632, 691; XIV, 1113; XIV-(2), 3. XV-(2), 8; XVI-(1), 107, 115.
proportioned to horsepower hours or tons of work performed, XI-(1), 691; XVI-(1), 108, 115.
varying with rise and fall (see Rise and Fall, Fuel Consumption.)
working standing, XI-(1), 636; XIV-(2), 3, 8; XV-(2), 4, 8, 27; XVI-(1), 108.

—Geared
seven per cent. grade on industrial tracks, sharp curves worked by geared engines, XVI, 969.

—Grate Area
ratio of heating surface to, XI-(1), 632.
steam per square foot heating surface for various qualities of coal and ratios of heating surface to grate area, XI-(1), 634, 635.

—Heating Surface
ratio of to grate area, XI-(1), 632, 645, 713.

—Helper Engine
balanced grades for, XI-(1), 333.
formula for computation of rate per cent. of helper grades, XII-(1), 333.
formula for, XII-(1), 333.
helper engine, V, 701; XII-(1), 330.
interest rate considered, II, 22; XVI-(1), 104, 111.
mile, cost of, V, 702.
table of, V, 701; XII-(1), 333.

—Horsepower
of locomotives, XI-(1), 631; XIII, 1153; XIV-(1), 631; XIV-(2), 8; XV-(2), 4.
varying with speed, IX, 778.

—Impact
some of the strains on track by various engines, X-(2), 1440, 1443.
(see Impact; Bridges, etc.)

Locomotive—Continued

—Mikado

Baltimore & Ohio Railroad, at different speeds and on different grades, XIV, 612, 633, 648, 649, 650.

—Oil Burning

comparison of oil with coal as fuel, XIII, 437.
evaporative tests with oil as fuel, XIII, 439.
locomotives, XIV, 633.

—Resistance

locomotive, XI-(1), 643, 644; XIV, 647.
train, XI-(2), 1322.
(see Resistance.)

—Steaming

steam per one horsepower hour at "M" velocity and various multiples of "M," XI-(1), 639; XIV, 644.
steam per square foot heating surface for various qualities of coal and ratios of heating surface to grate area, XI-(1), 634, 635.
steam producing capacity, XI-(1), 632, 635, 646, 713.
superheated steam, XVI-(1), 109.
weight of steam for one foot of stroke in cylinders of various diameters, XI-(1), 637, 638, 640, 642.

—Stoking

difficulty in firing enough low grade coal to supply at full cut-off above five miles per hour, XIV-(1), 1116.
firing by hand, rate of, XI-(1), 636; XIV-(1), 633, 1116; XIV-(2), 3.
firing by mechanical stoker, rate of, XIV, 633; XV-(2), 10; XVI-(1), 109.

—Thrust

nosing of locomotives, XIV-(1), 1109, 1130, 1134.

—Tonnage Rating

adjustment per car, XI-(1), 650, 651, 652, 653, 663, 687; XII-(1), 331; XIV, 618, 630, 639.
engine rating, Baltimore & Ohio Railroad, XI-(1), 663.
equated, Chicago, Burlington & Quincy Railroad, XIII, 1151.
formula for determining rating for locomotives, XI-(1), 649.
formula for grade resistance in engine rating, XIII, 1155.
locomotive tonnage rating and its derivation, XI-(2), 1312.
making up trains to equal locomotive rating, XI-(2), 686.
margin between tonnage rating and maximum tractive power, XIII, 1154; XIV, 613, 627, 1118, 1119.

Locomotive—Continued

—Tonnage Rating
of locomotives, I, 34; II, 22, 25; XI-(1), 649, 663, 666, 686; XI-(2), 1312, 1316, 1324; XIII, 1151; XIV, 599, 627, 631, 1116.
reductions for temperature, XI-(1), 654, 666.
tonnage rating, Southern Pacific Company, II, 22, 25.

—Tractive Power
adhesion, XI-(1), 647, 715; XIV-(1), 629.
comparison between actual and calculated, XI-(1), 670.
cylinder tractive power for one horsepower at various speeds, XI-(1), 642; XIV-(1), 646.
greater in dry climate, XI-(1), 715.
tractive force at speed, XIII, 1157.

—Velocity
attained and time required in passing over 15 miles, IX, 782-784.
average speed in motion between terminals compared, XIII, 1153.
comparative cost of fast and slow freight service, W. B. Poland, IX, 795.
economic and efficient speed of freight trains, John D. Isaacs and E. E. Adams, XI-(2), 1328.
fuel consumption and the speed diagram, A. K. Shurtleff, XIV-(2), 3.
maximum speed at full cut-off, IX, 790; XI-(1), 636, 646.
speed, coefficient for changing revolutions per minute to miles per hour, XI-(1), 638; XIV, 640, 643.
speed curves or diagram, XI-(2), 1316, 1319, 1320, 1327; XIV-(1), 1113; XIV-(2), 3, 8; XV-(2), 7; XVI-(1), 106, 112.
speed that may be maintained by given engine and train on a given grade, formula, XV-(2), 18.

—Weight
average weight of cars and loads, XIV, 583.
comparison of average weight per axle of engines and cars, XIV, 582.
diagram showing weight of typical engine, VI, 247, 250.
of train for given grade at given maintained speed, formula, XV-(2), 18.
tabulation of weights of heavy locomotives, VI, 246, 247.
weights of Chicago, Burlington & Quincy Railroad engines, XIII, 1160.
weights of Delaware, Lackawanna & Western Railroad engines, XVI-(2), 304.

—Yard
transfer and switch engine service in yards and terminals, system of handling and keeping records, IV, 350.

Loop Terminals
for passenger service, XI-(2), 1252-1254.

Loose Rock
removal by steam shovel, classification for loose rock, VI, 146.
(see Embankment; Excavation.)

Louvres
(see Tunnels.)

Lumber
(see Various Kinds; Cypress, etc.; Wood Preservation.)

—Defects
in construction oak timbers, XII-(3), 601.
in cypress lumber and timber, XIII, 875.
in Douglas fir, XII-(3), 548.
in Northern pine, XII-(3), 565.
in Southern yellow pine, XII-(3), 578.
sap as a defect in Douglas fir, XII-(3), 554.
—as a defect in Northern pine, XII-(3), 569.
—as a defect in Southern yellow pine, XII-(3), 583, 586, 587.
worm defects in oak timber, XII-(3), 602.

—Dimensions
specifications for barn or dimension cypress, XIII, 880.
standard sizes of dressed Douglas fir dimension lumber, XII-(3), 563.

—Grading
(see Battens; Boards; Columns, etc.; Lumber Specifications.)

—Knots
classification of in hemlock lumber, XVI, 907.
in Douglas fir, XII-(3), 548.
in Northern pine, XII-(3), 565.

—Panama Canal Rule
for grading lumber, XVI, 915.

—Pitch Pockets
in Douglas fir, XII-(3), 553.
in hemlock, XVI, 908.
in Northern pine, XII-(3), 569.
in Southern yellow pine, XII-(3), 583.

Lumber—Continued

—Rot

what constitutes rot in oak timber, XII-(3), 603.

—Rustic

Douglas fir, XII-(3), 559.
standard sizes, XII-(3), 563.

—Sap

as a defect in Douglas fir and Northern pine and Southern yellow pine, XII-(3), 554, 569, 583.

—Specifications

(see under Various Kinds of Lumber.)

—Standard Sizes

(see under Specifications for Various Kinds of Lumber.)

—Stepping

Douglas fir, XII-(3), 560.

—Worm

defects in oak timber, XII-(3), 602.

M

Machinery

(see Ballast; Pumping, etc.)

Malleable

specifications for iron castings, X-(1), 166.
specifications for tie-plates, XIV, 100, 1063.
(see Iron.)

Manganese

plan of frogs and crossings, XVI, 719-725.
rules for use in frogs, etc., XII-(1), 410; XVI, 718, 1140.
use of on Norfolk & Western and Lake Shore & Michigan Southern Railways, XII-(2), 28; XIII, 632.
(see Frogs.)

Maps

forms, records and maps, VI, 656; XI-(2), 1103.
requirements of Interstate Commerce Commission, XV, 943, 944.
—of Railway Commissioners of Canada, XV, 955.
right-of-way defined and described, IX, 663, 667, 670.

Maps—Continued
size, shape, arrangement and what should be shown, II, 319; VI, 651-659; IX, 663.
track, scale and what should be shown on, IX, 668-686.
—should single or double lines be used, argument and conclusions, X-(2), 835.

Marine Borers
creosote as protection against, X-(1), 634.
mechanical protection against marine borers (see Pile Protection.)

Masonry
(see Architecture; Concrete; Culvert, etc.)

—Bibliography
on masonry, XII-(1), 480; XIII, 459, 460.
on waterproofing, XII-(1), 564.

—Classification
of stone masonry, VII, 582; VIII, 628.

—Pointing
masonry, III, 302.

—Rubble
masonry, XI-(2), 1071.

—Stone
concrete as backing for stone face work, VI, 701.
laying on its natural bed, VII, 607.
relative cost between stone and concrete under certain conditions, II, 73.
specifications, VII, 581, 602, 606; VIII, 627; XII-(1), 478.

Master Carpenter
(see Supervisor of Structures.)

Mat (Waterproofing)
by use of mat or covering, XV, 521.

Material
—Forms
bridge foreman's monthly bridge material report, V, 249, 250.
classification of material accounts, II, 322.
master carpenter's report, V, 349.
remarks on, II, 317; III, 414.

Material—Continued

—Forms

report, III, 391, 392; VI, 650-662.
section foreman's material report, what it should show, with typical forms, VI, 650, 661, 668; X-(2), 837, 841, 845, 872.

—Scrap

care of, I, 150.
picking up, II, 293.

Mattress

(see Embankment.)

Megohms

(see Electric; Signals.)

Mill

(see Bridges; Rail, etc.)

—Inspection

form for report on, XIV, 188.

—Practice

inspection and testing at mills, IV, 133; VI, 232; VII, 199.
inspection of structural steel at mill; instructions to inspectors, XIV, 83, 1048.
mill tests of basic and acid steel, VI, 426.

—Reports

form for inspector's, XII-(2), 15; XIV, 188.

—Tests

mill tests of basic and acid steel, VI, 426.
(see Tests.)

Mitred Rails

for drawbridges, XVI, 1050.

Moment (Bending)

conversion of Cooper's E ratings into center bending moments, XVI-(2), 382.

Momentum

(see Grades.)

Mortar

for laying stone, constituents and proportions, III, 302.
for pointing, constituents and proportions, III, 302.

Motor
(see Signals.)

Movable Bridges
(see Bridges.)

Mouldings
specifications for moulded casing and base, door and jambs, Southern yellow pine, XII-(3), 592.

N

Nails
common, illustrated, size, length, gage and weight, V, 394.
(see also Dating.)

Natural Gas
in Canada, regulations for preventing waste, XIII, 457; XIV, 142.

Nick and Break Test
(see Rail.)

Nickel Steel
steel with chromium nickel, tests of rails, XIII, 631.
use of on Pennsylvania System, XII, 27.

Nitro-Glycerine
first use of, IV, 15.

Nutlocks
specifications for spiral spring, XIV, 103.

Nuts
thread, XIV, 1064.
(see Bolts; Track), XVI, 406.

O

Oak
construction oak timbers, XII-(3), 601.
diagram showing seasoning of red oak ties in Southern states, XVI, 868.
economy in, XV, 744.
knots in oak timbers, XII-(3), 602.
sap as a defect in construction oak, XII-(3), 603.

Oak—Continued

standard names for red and white oak used for construction purposes, XII-(3), 603.
weight of red oak ties in lbs. per cu. ft. at time of treatment, XIII, 869.
what constitutes rot in oak timbers, XII-(3), 603.
worm defects in oak timbers, XII-(3), 602.

Ocean Ports

angle berths compared with parallel, at water and rail terminals, XII-(1), 250.
description of export and storage piers at tidewater, IV, 363-372.
description of terminals, piers, tracks, etc., at ten ocean ports, V, 185.

—Steamers

conditions imposed on piers used, IV, 363.

Oil

(see Various Kinds; also, Wood Preservation.)

—Fuels

as a locomotive fuel, XIII, 438.
coal and oil as fuel compared, XIII, 451.
evaporative tests with oil as fuel, XIII, 439.
inspection, tests and specifications for fuel oil, XIII, 441.
specifications of the Bureau of Mines, XIII, 443.

—House

plan of typical oil house, XVI, 772.
recommended typical, X-(2), 1126-1136; XI-(2), 1037; XVI, 745.
requirements, XI-(2), 1027, 1054; XVI, 745.

—In Timber

table showing distillation of oil extracted from old creosoted timber, IX, 763.
table showing percentage of oils remaining in wood after long service, XV, 647.

—Locomotives

(see Locomotive.)

—Production

in the United States, 1859-1910, XIII, 445.
methods of preventing or lessening waste in the production of petroleum, XIII, 444.
of the world, XIII, 448.
rank of states in production, XIII, 447.

Oil—Continued

—Resources

of Canada, XIV, 142.
of the United States, XVI, 998.
time of exhaustion of oil fields, XIII, 449.

—Roadbed

crude petroleum for oiling roadbed, I, 93.
methods of applying to, I, 93; XIII, 295.
oiling, I, 91-94; XIII, 295.

—Water Tanks

specifications for ordinary iron or steel and water tanks, XII-(3), 348; XIII, 417, 984.

Open-Hearth Steel

—Plates

tests of, IV, 207.

—Rail

basic and open-hearth compared, XV, 241.
chemical analysis, XII-(2), 196.
classified, different weights, XII-(2), 24; XIV, 336; XV, 202; XVI, 219.
compared with Bessemer, XVI, 212.
comparison, different sections, XII-(2), 26; XIV, 336; XV, 202; XVI, 217.
failure of 100-lb. section, XII-(2), 39.
—of 90, 85, 80 and 75-lb. section, XII-(2), 47, 59, 70, 75.
influence of finishing temperature on open-hearth rails, XVI, 349.
influence of silicon on open-hearth ingots, XIV, 507.
on Baltimore & Ohio Railroad, XI, 541.
scleroscope test, XI, 503.
specifications for basic open-hearth rails, VII, 555; X-(1), 374; XIV, 199.

—Structures

for structural work, its advantages, IV, 143.

Operating Expenses

company forces for work which may interfere with operation, IX, 591, 609, 634; X-(2), 924.
movement of cars through yards and terminals, IV, 350.
problems in planning and operating yards, I, 17; II, 43.

Operating Expenses—Continued
table showing various items of operating expenses of Union Pacific Railroad, V, 693.
table showing numerous items used in connection with Union Pacific Railroad line revision studies, V, 690-718.
table of comparison of operating conditions in one hump and two flat yards, XVI, 986.
table of various items of cost as related to passenger and freight-ton miles, XIV, 584.
(see Economic Comparisons.)

Orders to Enginemen
the use of block signals in issuing orders to enginemen and conductors, IV, 293.

Ore
Mayari ore from Cuba, XIII, 631.
(see also Docks and Piers.)

Organization for

—Ballast Gang
for cleaning foul ballast, XV, 994.
—should it be done by extra gangs or regular section crew, XV, 997.

—Construction Department
organization of, XV, 68, 1005.

—Electrical
maintenance organization for electrically operated sections of a steam railroad, discussion by Committee, with two outline plans, XII-(1), 155, 162, 199.

—General
organization and code of titles; plan suggested by Committee; a comprehensive survey, I, 134.
science of organization, XVI, 67, 70.

—Grade and Curve Improvement Work
grade crossing elimination organization, XV-(2), 110.
organization for, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.

—Records and Accounts
bridge department, outline organization, V, 244, 348.
organization in storehouse, XV, 924.

Organization for—Continued

—Maintenance of Way Department

diagrams for, II, 238-240.
on an operating division, XI-(1), 36.

—Track Elevation

organization for, IX, 591; XVI, 572.

Overflow

anchoring track against, X-(2), 921, 1061, 1075; XVI, 573.
track anchored on bridges subject to overflow, X-(2), 921, 1105; XVI, 573.

Overhaul

(see Haul.)

P

Paint

painting steel railway bridges in shop, VI, 236; VII, 203.
painting structural steel in shop and field; kinds of covering and method of application, XIV, 421; XV, 412; XVI, 605.
—methods at bridge shops, XVI, 612-616.
—methods of railroads of United States and Canada, table, XVI, 614-618.
preservatives for painting and soaking; name, composition, cost, quantity, etc., II, 105.
protection of iron and steel structures against corrosion; pigments, preservative coatings and concrete encasement, XV, 412, 1045; XVI, 605.
selecting and procuring suitable paint for steel structures, season for applying and methods of cleaning metal before applying, X-(2), 1148; XIV, 421; XV, 412; XVI, 605.
specifications for painting an interlocking plant, X-(1), 110-144.
specifications, XVI, 510.
—for whitewash, XVI, 518.
table of information in regard to painting signs, XVI, 498.
table of information in regard to repainting bridges under traffic, XVI, 630.
tests made on Havre de Grace bridge, preservative coatings, XV, 415; XVI, 610.
(see Preservatives.)

Passenger

—Platforms

tracks and platforms in a number of cities, XI-(2), 1274-1308.

Passenger—Continued

—Stations

at Polk Street, Chicago, XI-(2), 1277.
avoiding delays, XII-(1), 237.
description and analysis of working capacity of Kansas City Union Station, XVI, 959.
—terminal development, Baltimore & Ohio Railroad, in Baltimore and Philadelphia, XI-(2), 1270.
distribution of space in passenger stations in cities, ten to fifteen thousand population, V, 38.
division of space in passenger stations, VI, 682; XI-(2), 1023; XVI, 739.
handling baggage and express, XII-(1), 237, 269.
notes on three new, XII-(1), 258.
number of trains handled, XII-(1), 238.
plans for stub and through type with track layouts, XII-(1), 237, 240.
sanitary provisions at medium-sized, XVI, 780.
stub end, XI-(2), 1283.
table of facilities and traffic at passenger terminals, XII-(1), 254.
terminal, level and loop types, XI-(2), 1250.
typical, XI-(2), 1270, 1277, 1283; XII-(1), 254.
working capacity of, XIV, 914, 925.
yard for passenger traffic at medium sized stations, XII-(1), 237, 240.
(see also Buildings.)

—Terminals

Kansas City Union Station layout, XVI, 960.
plan of Bush Terminal, Brooklyn, N. Y., V, 186.
track layouts at passenger terminal stations, XII-(1), 240.

—Tracks

tracks and platforms in a number of cities, XI-(2), 1274-1308.
(see Yards.)

Passing Sidings

(see Signals; Track.)

Paving

concrete substructure under crossings and under tracks in paved streets, XIV, 819.
drainage under crossings and tracks in paved streets, XIV, 818.
highway crossings, paved and unpaved streets, country roads and private or farm roads, X-(2), 878; XI-(2), 1237-1246.
track construction in paved streets, X-(2), 878; XI-(2), 1238; XIV, 818, 1116; XVI, 443, 1043.

Peat

deposits of Canada, XIII, 457; XIV, 140.

Penstocks

proportioning supply line for water column, X-(1), 758.

Permissive Blocking

(see Signals.)

Petroleum

crude for oiling roadbed, I, 93.
crude, XI-(2), 752, 851.
diagram showing quantity and value of petroleum produced in the United States and the world, 1859-1913, XVI, 999.
life of crude, XI-(2), 752, 767, 769, 772; XVI, 880.
methods of preventing or lessening waste in the production, XIII, 444.
production of in the United States, XIII, 445-448.
rank of states in the production of, XIII, 447.
resources of Canada, XIV, 142.
substitutes for, XIII, 448.
tar creosote, XI-(2), 753.
waste of crude petroleum and natural gas in Canada and measures being taken to prevent continuance, XIII, 457.
(see Oil.)

Phosphorus

carbon should be increased when low phosphorus can be secured, XI-(1), 238.
diagram showing carbon, phosphorus and sulphur in 25 test ingots, XIII, 681-685.
diagram showing carbon, phosphorus and sulphur in axis and wall of test ingot, XIII, 806.
in rails, XIII, 1026.

Physical Tests

(see Rail, etc.)

Piers

plans of typical, IV, 358, 360, 362, 366, 368.
(see Docks.)

Piers—Continued

—Coal

coal piers of Baltimore & Ohio Railroad at Curtis Bay, Md., V, 146.
coal pier of Pennsylvania Railroad at Greenwich Point, Philadelphia, V, 152.
coal pier of Norfolk & Western Railway at Lambert's Point, Va., V, 155.
(see Coal.)

—Freight

plan of typical in and outbound freight pier, IV, 366.

—Ocean

arrangement of loading tracks, XII-(1), 250.
arrangement of tracks on a coal pier, V, 141.
export and storage piers, IV, 363, 372.
flour warehouse for export pier, IV, 364, 370.
freight handling equipment, XIV, 954.
height of piers at tidewater, IV, 361.
lighterage, IV, 357, 372.
on Lake Erie for handling coal and ore, V, 202.
plan of piers at Seattle, Wash., V, 200.
plan of piers and docks at Cristobal, Canal Zone, XII-(1), 250-252.
steamers, conditions imposed on piers used, IV, 363.
terminal, V, 185.
track layout on, XII-(1), 250.

Piles

—Bibliography

on piles and pile-driving, X-(1), 579.

—Concrete

adaptability to certain positions as a backing for stone face work, VI, 701.
cost of, XVI, 796.
description of, III, 303.
embedding large stones in the interior of heavy structures, VI, 702, 725.
injury from using green cement, II, 92, 93.
plan of various reinforced concrete piles, XII-(1), 300-302; XVI, 798.
practice of various roads in use of concrete piles, XVI, 824.
should dust be excluded from crushed stone used in, V, 637.
surface finish, XV, 800, 1175.
types of, XI-(1), 203, 205, 208, 211, 212.

Piles—Continued

—Driving

form for pile driving record, XI-(1), 185.
type of pile driver for land, water or track, X-(1), 568.

—Life of

piling of various timbers, II, 139.
result of tests of treated Oregon fir piling, XVI-(2), 89-129.
tests of Oregon fir piling, XVI-(2), 130-138.

—Sheet

wooden and sheet piling, X-(1), 569, 570.

—Shoes

pile, XI-(1), 195.

—Splices

pile, XI-(1), 192.

—Timber

pile and framed trestles, plans of, V, 732, 733, 740, 745; VI, 44.

—Trestles

(see Trestles.)

Pine

—Heart

percentage of heart measured on face at center of cross-section of pine, IX, 381.

—Northern

classification of knots, XII-(3), 565.
defects in, XII-(3), 505.
fencing, XII-(3), 573.
finishing, XII-(3), 570.
flooring, XII-(3), 573.
joists and scantling, XII-(3), 575.
pitch pockets, XII-(3), 569.
sap as a defect in, XII-(3), 569.
specifications, XII-(3), 574.

—Southern

specifications for bridge and trestle timber, XII-(3), 586.

Pine—Continued

—Southern Yellow

finishing, XII-(3), 587, 596.
Forest Service rule for grading, XVI, 1185.
mouldings, XII-(3), 592.
specifications for byrkit lath, XII-(3), 598.
structural, XVI, 915.

Pipe

—Air

and water, in freight car repair yard and passenger coach cleaning yard, III, 259, 260.

—Discharge

formulas for determining economical proportion of discharge pipe lines, X-(1), 739.

—Lock Joint

plan of lock joint pipe pile protection, XI-(1), 206.

—Roadway

correct way of laying, X-(2), 983.
drainage of water pockets in roadbed by pipes, XVI, 599.
for sub-drainage, X-(2), 1069, 1096, 1105.
water, sewer and gas, moved by companies owning, IX, 591, 610, 641; XVI, 572.

—Sewer

water, sewer and gas, moved by companies owning, IX, 591, 610, 641; XVI, 572.

—Signals and Interlocking

carriers for interlocking installation, X-(1), 94.
compensation in pipe line for interlocking plant, X-(1), 95.
specifications for, X-(1), 164.
wrought-iron, why not specified, X-(1), 209.

—Water

an expensive pipe line, showing economy on a road where efforts at treatment failed, IX, 114.
bibliography on flow of water in pipes, XI-(2), 1218.
cost and capacity of pipe line, discussion and formulas, X-(1), 738.
diagrams showing friction in cast-iron pipe, XI-(2), 1214.

Pipe—Continued

—Water

formulas and diagrams for determining loss of head through friction in pipe lines and water columns, XI-(2), 1164.
loss of head in feet in new straight pipe, XI-(2), 1216.
tests at University of Illinois to determine friction factors in pipe lines and water columns for engine supply, XI-(2), 1161.

Piping

(see Rail.)

Pitch Pockets

in Douglas fir, Northern pine, Southern yellow pine and hemlock, XII-(3), 553, 569, 583, 908.

Pit

(see Gravel Pit.)

Pit Guards

analysis of objections to, V, 386.

Plans

(see Bridges; Concrete, etc.)

Plant for

—Ballasting

for burning clay, X, 697.
for washing and screening gravel, X-(1), 685, 690; XIII, 103.
machinery and equipment of a quarry for producing crushed rock ballast, X-(1), 678.
mechanical devices for handling, XVI, 1017.

—Grade Elimination

plant used in grade crossing elimination at Cleveland; New York, Chicago & St. Louis Railroad, XV, 113.

—Gravel

for washing and screening gravel, X-(1), 685, 690; XIII, 103.

—Icing

on the Lake Erie & Western Railroad, V, 174, 176.

—Pumping

(see Water Service.)

—Timber Treatment

wood preserving plants in the United States, IX, 737; XI-(2), 762; XII-(3), 457.

Plant for—Continued

—Tunnels
plant for cooling the air in tunnels, XIV, 974, 980.

—Water Service
(see Water Service.)

Platforms
instructions regarding, XIV, 67, 1037.
lighting, XVI, 779.
moving, for handling freight, IX, 534; XI-(2), 1266.
passenger tracks and platforms in a number of cities, XI-(2), 1346-1377.
to freight houses, III, 262, 265, 281.
transfer, X-(1), 259, 261, 262.

Plows
—Roadway
early use of unloading, IV, 15.
plowing for embankments on hillsides, II, 16.
unloading, III, 49, 53; VIII, 303, 304, 347, 348.

—Snow
rotary and flangers, X-(2), 883-889; XI-(2), 1240; XVI, 442.

Plumbing
sanitary provisions at medium-sized passenger stations, XVI, 780.
toilet rooms in passenger stations, V, 37, 45; VI, 682; XI-(2), 1022; XVI, 781, 782.

Pneumatic Tamper
pneumatic tie tamper, XVI, 1017.
(see Ballast.)

Pointing
mortar, III, 302.

Poles
accidents to, XII-(1), 202.
advantages and disadvantages of treated poles and cross-arms, XI-(1), 211.
loading of poles in overhead construction, XII-(1), 204.
number, cost and kind of wood, of telephone and telegraph poles purchased in 1907-1909, XII-(3), 456.
preservative treatment, some considerations as to methods, XII-(1), 211.

Posts

—Fence and Sign

comparative cost of steel and wood fence posts, XIV, 796; XVI, 497.
discussion on, XIV, 791.
experience of railroads with, XIV, 808; XVI, 480.
posts for fences, length, size and material, V, 382.
specifications for, XVI, 437.
steel fence posts, XIV, 794.
tests of twenty posts, XIV, 812.
types of concrete fence posts, X-(2), 898, 916; XII-(3), 614; XIV, 808, 1172.
use of in foreign countries, XI-(2), 1241.

—Flanger

wing and flanger posts, X-(1), 892.

—Lamp

combination lamp and sign post, XVI, 778.

—Rules

must be kept plumb and so as not to be obscured, XIV, 67, 1036.

—Steel

comparative cost of steel and wood fence posts, XIV, 796; XVI, 497.
fence posts, XIV, 794.

—Wing

and flanger posts, X-(1), 892.

Power

(see Locomotive; Drills.)

Preservatives

(see Paint; Wood Preservation; Treatment.)

Pressure

(see Ballast; Foundation, etc.)

Prices

(see Contract.)

Profiles (Roadway)

grade line on profile denoting sub-grade, IV, 78.
plan and profile of humps of various yards, VII, 137-142, 148-158, 162; IX, 517-522, 524; X-(1), 302.
showing distribution of material, IV, 32; V, 687; VI, 144, 145; XI-(2), 1063.
virtual profile, I, 34.

—Progress

form of, VII, 278.
practice of different railroads, VII, 314; VIII, 138.

—Quantity

profile of quantities, VII, 362, 367.

—Record

maps and profiles, requirements of Interstate Commerce Commission, XV, 943, 944.

Protection

(see Crossings; Embankment, etc.)

Pumping

(see Water Service.)

Q

Quarry

machinery and equipment of a quarry for producing crushed rock ballast, X-(1), 678.

Quenching

(see Rail.)

Quicksand

removal of, XIII, 391.

R

Rail

—Abrasion Tests

on revolving machine, XIV, 213.

—Acid Steel

comparison between basic and open-hearth rails, and influence of reheating cold blooms, XV, 241,

Rail—Continued

—Adhesion

of damp rails in tunnels, XI-(2), 1066, 1073.

—Aluminum

influence of aluminum and silicon on segregation, XV, 350.
influence on Bessemer ingots and rails, XV, 337.

—American Mill Practice

American mill practice, XII-(2), 16.

—Analysis

of test ingots, XIII, 551.
(see this clause in Specifications.)

—Axle Loads

flow of head under wheel loads, XII-(2), 535.
in 1900 as affecting weight of rail, II, 189.

—Base

allowable variation in, III, 212.
breaking load on base of rail, XIV, 327.
broken base failures, XI-(1), 436, 445; XII-(2), 382; XIV, 178; XV, 369.
ductility influenced by seams in base, XV, 267.
laminations in base, influence on ductility, XV, 153, 267.
seams or laminations influencing base failures, XIV, 178, 315.
study of different, XV, 267.

—Bending Tests

crossbending on base, XIV, 280; XV, 229, 257, 264.
of rails, XII-(2), 410, 424, 445, 465.
result of bending test on rails, XII-(2), 410, 443.
slow bending test, XVI, 169.

—Bessemer

(see Bessemer.)

—Bibliography

of iron and steel papers, II, 196.
on production of sound ingots, XIV, 446.
on stresses on rails in service, XIV, 570.

—Blooms

carbon in, XIII, 761.
influence of amount of draft in blooming, XV, 152, 211.
influence of reheating on cold blooms, XV, 241.

Rail—Continued

—Blooms

photographs taken at Watertown Arsenal, showing flaws in blooms and rails, IX, 480.
shearing on top, VII, 549, 559; XI-(1), 254.
streaks and fissures in rails and blooms, as shown by photographs, IX, 480.

—Braces

spreading of track prevented by rail braces, II, 272; III, 60.

—Branding

clause in specifications, II, 194; V, 467, 469; XI-(1), 255; XIII, 571; XIV, 187; XV, 381.

—Broken Rail

breakages occur largely on left-hand rail, XII, 470.
breakage statistics, VII, 550; XI-(1), 237, 286, 320; XII-(2), 21; XIII, 613; XIV, 174; XV, 152; XVI, 153.
definition of, XII, 468.
effect of counterbalancing on rail breakages, XII, 472.
forms for reporting, IX, 447-511.
tabulation of, XII-(2), 231.
thoughts resulting from study of rail failures, XII-(2), 28.
with split head, XI-(1), 443.

—Built-up

expansion experiments on Michigan Central Railroad with built-up rails, 250 ft., 500 ft. and 800 ft. long, I, 132.
experience of Michigan Central Railroad with, I, 132.

—Burns

due to slipping of engine drivers, cause of failures, XI, 552.

—Camber

amount allowable, XI, 568.

—Canadian

and United States rails, I, 112.

—Canting

of rails, XVI, 1132.

—Carbon

analyses, XVI, 162.
and deflection, XII-(2), 222.
carbon, phosphorus and sulphur in rails from test ingots, XIII, 713-716.

Rail—Continued

—Carbon

deflection in drop tests, XVI, 167.
drop tests, XVI, 164.
elongation in drop tests, XVI, 168, 177.
formulas, XVI, 168, 175, 176, 187, 188.
how rail is affected by high percentage of carbon, VII, 568, 571.
in blooms, XIII, 761.
rolling, XVI, 181.
should be increased when low phosphorus can be secured, XI-(1), 238.
shrinkage, XVI, 162.
slow-bending tests, XVI, 169.
specifications for carbon steel rails, XIII, 565; XIV, 169, 181; XV, 375; XVI, 157.
tensile test, XVI, 169.
test, XVI, 161.
transverse of base test, XVI, 178.

—Chair

cast-iron, XV-(2), 389.

—Chemical Analysis

chemical composition does not insure good wearing rails, VI, 178, 179.
composition, III, 204; V, 465; VII, 553; XI, 564; XIII, 565; XIV, 199; XVI, 157.
form of chemical and physical examination of rails, X-(1), 345.
laboratory report of chemical and physical examination of rail and other track material, X-(1), 353; XI-(1), 250.
of constituents, XII-(2), 197-221, 397, 415, 432, 451, 483, 497.
of old John Brown & Co. Bessemer rails, VI, 179.
standard location of borings for, XII-(2), 14.
tests of rails with transverse internal fissures, XIV, 439-447.

—Chrome Steel

comparison with Bessemer, XII-(2), 27.
(see Alloys.)

—Chromium Nickel

record of tests of some rails of steel with chromium nickel, XIII, 631.
(see Alloys.)

—Classifying

rails at mill, XI-(1), 257.

Rail—Continued

—Cold Straightening
failures from, IX, 447.
failures may result from, or minor causes, IX, 477.
of rails is loading beyond elastic limit, IX, 477.
rupture caused by, IX, 477.

—Counterbalance
effect of counterbalancing engines on breakages, XII, 472.

—Cracks
caused by gag, XVI, 1126.
development of, XII-(2), 492.
in ingots produce seams in rails, XV, 315.

—Crushed Head
failures, XI-(1), 408, 445; XII-(2), 257, 321.

—Crystallization
caused by slipping engine drivers leads to rail failures, XI, 552.

—Dark Streaks
ghost lines or gas seams, dark streaks and rolling flaws as faults in rails, IX, 503.

—Defects
interior, in rails, their existence and prevention, IX, 504.

—Definitions
of broken rail, XII, 468.
of rail failures, IX, 448.

—Deflection
carbon and deflection drop test, XII-(2), 222.
ductility and deflection on drop test, XIII, 1021; XIV, 261.
in carbon test, XVI, 167.
of Bessemer test rails, XIII, 819.
under drop test should be limited, XI-(1), 238.

—Design
American Railway Association rules governing, IX, 431.
improvement in design of rails from 1893 to 1912, XIII, 853.
proportioning, IX, 431.
rules and principles which govern the design of rail section, IX, 431.

Rail—Continued

—Development

of rails and accessories, XVI-(2), 7.

—Dimension

allowable variation in height, III, 205, 209.
principles governing, IX, 432.

—Draft

influence of amount of draft in blooming, XV, 152, 211.

—Drift Test

on steel, III, 248.

—Drilling

for rails, III, 205; XI-(1), 240, 255.
plan of drilling for rails, XV, 156.
standard, XI-(1), 240; XV, 156.
standards used, IV, 515; VI, 757.

—Drop Test

at Bethlehem Steel Company, XII-(2), 208.
at Carnegie Steel Company, XII-(2), 190.
at Illinois Steel Company, XII-(2), 216.
at Maryland Steel Company, XII-(2), 213.
at Pennsylvania Steel Company, XII-(2), 196.
at Tennessee Coal, Iron & Railroad Company, XII-(2), 202.
deflection under drop tests should be limited, XI-(1), 238.
detects too hot finishing, V, 478.
drop testing machine, comparison of results obtained with old style and new standard machines, IX, 373.
form for reporting, XII-(2), 16.
formulas for deflection, XVI, 189.
height of drop, XI-(1), 256.
its limitations, XIII, 1021.
of Bessemer test rails, XIII, 701-706.
of ingots, XIII, 695-699.
of rails, I, 130; II, 192; IV, 281; V, 465; VI, 183; VII, 551; X-(1), 372; XI-(1), 455, 456; XII-(2), 188, 385, 389, 408, 423, 442, 463, 508, 529; XIV, 170, 199, 255; XV, 222, 249; XVI, 157, 355.
special to determine effect on rail of size of ingot, XIII, 690.
standard drop testing machine, X-(1), 370.

Rail—Continued

—Ductility Tests

ductility of metal in rail head and its exhaustion through flow, IX, 476.
elongation on ductility, XIII, 1028; XIV, 170; XVI, 168, 177.
laminations in base, influence on ductility, XV, 153, 267.
of New York Central, XII-(2), 548; XIV, 199.
special rails tested to determine effect of size of ingot on ductility, XIII, 700.
transverse ductility of base, XIV, 280; XV, 257, 264; XVI, 178, 362.

—Elongation

results of tests on New York Central, XIV, 200-208.
tests, XVI, 167, 177.

—Etching

tests, XII-(2), 395, 434, 453, 471, 501; XIII, 777.

—Expansion

experiments of Michigan Central Railroad with built-up rails, 250 ft., 500 ft. and 800 ft. long, I, 132.
rules for proper laying of rails, II, 190.

—Failures

base failures, seams or laminations influencing, XIV, 178, 315.
breakage statistics, VII, 550; XI-(1), 237, 286, 320; XII-(2), 21; XIII, 613; XIV, 174; XV, 152; XVI, 153.
breaks starting from a blow from a spike maul, VII, 568, 571.
characteristic, XI-(1), 237, 387, 453.
comparison at different lengths of life, XII-(2), 102; XIII, 627.
definitions, IX, 448.
diagram showing total rail failures to 1913 grouped by weights and sections, XVI, 221.
effect of counterbalancing engines on breakages, XII, 472.
forms for reporting, IX, 434, 447.
from cold straightening, IX, 447.
general statistics of small value, XIII, 1017.
how affected by high percentage of carbon, VII, 568, 571.
occur in first years of life of rail, XI, 578.
occur largely on left-hand rail, XII, 470.
position in ingot of rail which failed, XI-(1), 304-307, 375-384; XII-(2), 105-134.
rail comparison between different weights classified, XI-(1), 259.
reported and studied on Harriman Lines, X-(1), 377.
—comparison between different manufactures, XIV, 336; XV, 208.
—comparison at different lengths of life, XIII, 636.

Rail—Continued

—Failures
—per ten thousand tons, XVI, 225.
—showing percentages of failures in head, web and base, and broken, grouped by weights and sections, XVI, 222, 223, 225.
slipping of drivers causing burns and crystallization, resulting in rail failures, XI-(1), 552.
summary of for six months compared with previous year, XI-(1), 286; XII-(2), 81-91.
thoughts resulting from study, XII-(2), 28.
with respect to composition, XIV, 342.

—Ferro-Manganese
on Norfolk & Western and Lake Shore Railways, XII-(2), 28; XIII, 632.

—Ferro-Titanium
results from use of, XIII, 630.

—Finishing Temperature
at low temperature, II, 200.
drop tests detects, V, 478.
influence of finishing temperature on open-hearth, XVI, 349.
shrinkage of rails to determine temperature at finishing, V, 466, 469, 479; VII, 551, 562; XI-(1), 254; XVI, 166, 352.

—Fissures
and streaks in rails as shown by photographs, IX, 480.
transverse or internal in head, XIV, 413; XVI, 156, 195, 1122.

—Flow of Metal
ductility of metal in rail head and its exhaustion through flow, IX, 476.
failures due to flow of metal, XI-(1), 403, 445; XII-(2), 267, 319.
in head of 100-lb. rail reducing tensile strength, IX, 493.
skidding of engine wheels causing flow of metal in rail head, IX, 494.

—Forms
of the Pennsylvania Railroad, IX, 449, 466; XII, 16; XIV, 172.
record blanks, IX, 449; X-(1), 339, 345.

—Formulas
for deflection, drop test, XVI, 189.

—Gag
cracks caused by, XVI, 1126.
gagging may injure rails, XVI, 1121.

Rail—Continued

—German Rail
types of, XI-(2), 1342.

—Good Rail
analysis of good wearing rails, VI, 178, 179.
a study of seventeen good service rails, XIII, 573.
what makes, VI, 175, 179.

—Granular Structure
governed by heat, I, 118, 121.

—Hammer Blow
leading to fracture of 100-lb. rail, IX, 501.

—Handling
rules for handling rail, XIII, 66, 67, 924.

—Hardness
methods of determining, XI, 494.

—Head
failures classified by types and weights, XIII, 625; XIV, 352; XV, 181.
flow of under wheel loads, XII-(2), 535.
silvery oval spots, XIV, 413.
strength of, XII-(2), 518.
transverse or internal fissures in, XIV, 178, 413.

—Historical
account of rail development, I, 113; XIII, 843.
of use of rails for track, IV, 516.

—Homogeneity
in rail steel, indication of weakness, IX, 501.

—Hot Finishing
drop tests detects, V, 478.

—Impact Tests
(see Tests.)

—Ingots
(see Ingots.)

—Injury
to steel from pressure in working, IX, 508.

Rail—Continued

—Inspection
certificate, form for, 402.
clause, XI-(1), 257.
inspector's mill report, form for, XII-(2), 15.

—Interior Defects
their existence and prevention, IX, 504.

—Internal Stresses
in rails, XIII, 1023.

—Joints
rail, XI-(1), 240; XV, 156.
(see Track.)

—Laboratory Test
report, X, 340.

—Laminations
comparative effect of on strength, XV, 298.
influence on ductility, XV, 153, 267.
influencing base failures, XIV, 178, 315.
where they occur, XII-(2), 386.

—Laying
rules for, XIII, 66, 67, 924.

—Length
experience with long rails on Michigan Central Railroad, I, 132.
long, at road crossings, II, 206.
of rails, I, 119; II, 190; III, 205; V, 467; XI-(1), 255, 568; XVI, 156.

—Life
investigation, XIII, 851.
of rail statistics not useful, VII, 549.

—Load
breaking load on base of rail, XIV, 327.
load compression curve of rail and tie-plate, XI-(2), 830.

—Manganese
on Norfolk & Western and Lake Shore Railways, XII-(2), 28; XIII, 632.

Rail—Continued

—Manufacture

American steel rail mill practice, XII-(2), 16.
comparison between different manufacturers, XIV, 336; XV, 208.
details, XIII, 858.
details should be left to mills, provided physical tests are met, XI-(1), 238.
investigation, XIII, 851.
process of, III, 201; XI-(1), 254.

—Mayari

on Pennsylvania Railroad, XII-(2), 28.
ore from Cuba, XIII, 631.

—Mechanical Treatment

high importance, account of some changes in methods of working steel in rail making, I, 117, 121.
in making rails, I, 117, 125; II, 214.

—Microscopic Tests

microstructure, microphotographs showing structure of rails finished at different temperature, XIII, 832.

—Mill Practice

American, XII-(2), 16.

—Mill Report

form for inspector's, XII-(2), 15.

—Mitered Rail

for drawbridges, XVI, 1050.

—Moon-shaped Fracture

in 75-lb. rail, causing break after nine years' service, IX, 491.

—Nickel Steel

for rails, I, 128; XIII, 631.
on Pennsylvania Railroad, XII, 27.

—Nick and Break Test

or test to destruction, XIII, 567.

—Nicks

comparative effect on strength, XV, 298.

—Open-Hearth

(see Open-Hearth.)

Rail—Continued

—Output
tons of rail rolled annually, 1850-1911, XVI-(2), 10.

—Overstraining
in either tension or compression lowers elastic limit, IX, 475.

—Passes
reducing, XII-(2), 386.
temperature at finishing pass, effect on quality of steel, I, 121; II, 200; VI, 177, 180.
temperature at finishing point or final pass, VII, 552, 553; XI-(1), 255.

—Piping
effect of on the finished rail, XIV, 178, 401.
in rails, frequency of occurrence, cause and remedy, VII, 549.
result of tests to secure ingots free from pipes, XIV, 293, 301.
where it occurs, XII-(2), 386.

—Phosphorus
carbon should be increased when low phosphorus can be secured, XI-(1), 238.
in axis and wall of test ingot, XIII, 806.
in rails, XIII, 1026.
in test ingots, XIII, 681-685.

—Physical Properties
influenced by carbon, XVI, 161.
of rails, III, 204; XIII, 857.

—Physical Tests
of rails, XI, 454.
requirements (see Specifications).

—Position in Ingot
report of position in ingot of failed rail, X-(1), 358; XI-(1), 251.

—Pressure on
and stresses in track, X-(2), 1432.
in working as a cause of injury, IX, 508.
produced by different types of steam locomotives, X-(2), 1432.

—Quality
depends on physical treatment, VI, 177.
of rail little affected by section, XI, 561.

Rail—Continued

—Quality
of steel affected by amount of work it receives, IX, 508.
temperature at finishing pass, effect on quality of steel, I, 121; II, 200; VI, 177, 180.

—Quenching
specifications for heat treated, oil-quenched joint bars, XVI, 404.

—Reports
certificate of inspection of rails, X-(1), 346.
location of rail removed, X-(1), 360-363.
of rail failures, IX, 434.
of shipment of rails, X-(1), 347.
position in ingot of failed rail, X-(1), 358; XI-(1), 251.
required, X, 339.
review of made prior to 1909, X-(1), 335.

—Rerolling
process, II, 217.

—Rolling
flaws, a fault in rail, IX, 503.
of rails, XVI, 181.
results in yield point, tensile strength, elongation and reduction of area of drop test of rail tested to determine influence of rolling temperature, XIII, 822, 826.
speed of, influence on rail, XII-(2), 386.
temperature, influence on rail, XII-(2), 386; XIII, 797.
wear dependent on method of, VI, 177, 180.

—Scleroscope Test
a discussion of its usefulness and limitations, XI-(1), 511.
and its use, XI-(1), 494.
of open-hearth rail, XI, 503.
titanium test, XI, 510.

—Seams
crack in ingots produces, XV, 315.
gas in rail, IX, 496, 503.
in base, XV, 267.

—Section
A. R. A., Series A, IX, 441; XII-(2), 143.
A. R. A., Series B, IX, 446; XII-(2), 144.
A. S. C. E., XI-(1), 267; XII-(2), 145.
Dudley (B. & A.), XI-(1), 269; (N. Y. C.), XII-(2), 146.
miscellaneous sections, XII-(2), 176, 282, 284.

Rail—Continued

—Section

N. Y., N. H. & H., XI-(1), 268; XII-(2), 149.
P. R. R., XI-(1), 266; XII-(2), 148.
80-lb. A. S. C. E., N. Y. C. L., A. R. A.-A., A. R. A.-B., Erie, H. V., Great Northern, XI-(1), 279, 280; XII-(2), 168, 169, 170, 171, 172, 173, 174, 175, 280.
85-lb. A. S. C. E., P. R. R., C., B. & Q., C. R. R. of N. J., A., T. & S. F., C. P. R., Penna. Lines, etc., XI-(1), 274, 275, 276, 277; XII-(2), 160, 162, 163, 164, 165, 166, 167.
90-lb. A. R. A.-A., XI-(1), 271; XII-(2), 153.
90-lb. A. R. A.-B., XI-(1), 272, XII-(2), 154.
90-lb. A. S. C. E., XI-(1), 273; XII-(2), 155.
90-lb. A., T. & S. F., XII-(2), 156.
90-lb. N. Y., N. H. & H., XII-(2), 158.
90-lb. Great Northern, XII-(2), 159.
91-lb. D., L. & W., XII-(2), 152.
95-lb. B. & A., XI-(1), 270; XII-(2), 151.
100-lb. P. S., XI-(1), 265; XII-(2), 147.
100-lb. P. & R., XII-(2), 150.
100-lb. A. R. A., —R. E., XVI, 398.
110-lb. A. R. E. A., XVI, 399.
120-lb. A. R. E. A., XVI, 400.
130-lb. A. R. E. A., XVI, 401.
140-lb. A. R. E. A., XVI, 402.
quality of rail little affected by, XI, 561.
rules and principles which should govern design of a rail section, IX, 431.
standard, XI-(1), 235, 239, 265; XII-(1), 474; XII-(2), 12, 143; XIV, 173; XV, 151, 1104; XVI, 151, 397, 1117.
types of early, from 1820 to 1900, I, 115.

—Segregation

in Bessemer rails as influenced by size of ingot, XIII, 655, 686, 714.
influence of aluminum and silicon on, XV, 350.
method of revealing segregation in ingots, XIV, 487.
of metal, XI-(1), 444.
restraining in rails and placing where it will do the least harm, IX, 506.

—Service

study of seventeen rails giving good service, XIII, 573, 611.
thoughts resulting from study, XIII, 633.

—Shapes

derivative, tests at Watertown Arsenal, XIII, 753.

Rail—Continued

—Shearing
clause in specifications, XI-(1), 254.

—Shrinkage
benefits from use of shrinkage clause in specifications, VI, 180, 190; VII, 552, 562.
carbon test, XVI, 162.
of Bessemer test rails, XIII, 820.
of rails to determine temperature at finishing, V, 466, 469, 479; VII, 551, 562; XI-(1), 254; XVI, 166, 352.
size of grain of Bessemer steel rail in relation to shrinkage, XIII, 836.

—Silicon
influence of on open-hearth ingots, XIV, 507.
influence of silicon on segregation, XV, 350.
influence on steel rails, XIV, 524, 560.

—Slipping Wheels
burns due to slipping of engine drivers, cause of failures, XI, 552.
cause flow of metal in rail head, IX, 494.
crystallization caused by slipping engine drivers leads to rail failures, XI, 552.

—Slow Rolling
or fast and its effect on quality of rails, I, 117; VI, 177, 180.

—Spacing in Track
amount necessary, I, 131, 132; II, 190.

—Special Rail
record of comparative wear of, XI-(1), 308.

—Specifications
discussion of by James E. Howard (Bureau of Standards), XIII, 1020.
for rail, III, 204; V, 465; VI, 176; VII, 552; X-(1), 1, 374; X-(1), 237; XI, 254, 560.
synopsis of American rail specifications, II, 192.

—Split Head
failures, XII-(2), 469.
(see also Failures.)

—Split Web
failures, XI-(1), 428, 445.

Rail—Continued

—Stiffness

needed for efficient track superstructure, VIII, 55.

—Straightening

cold straightening of rails is loading beyond elastic limit, IX, 477.
specifications, VII, 554; XIV, 171.

—Stremmatograph Tests

Dr. P. H. Dudley's stremmatograph tests of railway track, XIV, 567.

—Strength

and endurance of rails; an account of tests and studies made at Watertown Arsenal to determine effect of various flaws and imperfections in ingots and rail, IX, 475.
nicks, comparative effect on strength of, XV, 298.
of head, XII-(2), 518.
results of tests to determine strength of base of rail, XIV, 319, 322, 329.

—Stresses

bibliography on stresses on rails in service, XIV, 570.
internal, XIII, 1023.
produced by different types of steam locomotives, X-(2), 1432; XV, 157.

—Talbot Process

steel, I, 129.

—Temperature

at finishing pass, effect on quality of steel, I, 121; II, 200; VI, 177, 180.
effect of cold on rails in the permanent way, XIII, 849.
finishing at low temperature, II, 200.
influence of on open-hearth, XVI, 349.
influence on the properties of Bessemer rails, XIII, 797.
its effect on rails and expansion allowance in laying, I, 132; II, 190.
rails improved by finishing at a lower temperature, I, 118.

—Tensile Strength

flow of metal in head of 100-lb. rail reducing tensile strength, IX, 493.
result of tests, XIII, 822-826.

Rail—Continued

—Tensile Test

carbon, XVI, 169.
record of, XII-(2), 418, 434, 454, 485; XIII, 762; XIV, 278; XVI, 173, 364.
standard locations of borings for chemical analysis and for tensile test pieces, XII-(2), 14.

—Test Pieces

for tensile tests of rails, standard locations, XII-(2), 14.

—Tests

(see various kinds noted under Rail.)

—Thrust

against rail by different types of engines, X-(2), 1440.

—Titanium

alloy, comparative wear, XII, 27; XIII, 630; XVI, 226.
analyses of ingots to determine influence of titanium, XIV, 227.
influence of on Bessemer rails, XIV, 219.
influence of titanium on seven test ingots, XIV, 247-285.
scleroscope test, XI, 510.
segregation influenced by titanium in Bessemer ingots, XIV, 246.
tests of Bessemer rails, XII-(2), 399, 417; XIV, 219.
tests of ferro-titanium rails, results on different railroads, XIII, 630.
tests of titanium rail on the Baltimore & Ohio Railroad, XI-(1), 546.

—Tonnage

tons of rail rolled annually, 1850 to 1911, XVI-(2), 10.
upon different weights, XIII, 847.

—Toughness

of steel in rail and its loss through service, IX, 475.

—Transverse Fissure

or internal, in head, XIV, 178, 413; XVI, 156, 195, 1122.
physical and chemical tests of rails with transverse internal fissures, XIV, 439, 447.

—Transverse Tests

results of tests to determine transverse ductility of rails, XIV, 280, 307, 313; XV, 257, 264; XVI, 178, 362.

Rail—Continued

—Watertown Arsenal Tests

current testing work being done at the laboratory, IX, 480.
photographs taken at Watertown Arsenal, showing flaws in blooms and rails, IX, 480.
shapes, derivative tests, at Watertown Arsenal, XIII, 753.
test of ingot at, XIII, 753.
tests of early English, French and German rails and of later American rails, IX, 475.
tests of splice bars, XII-(1), 13.

—Wear

as affected by tonnage, XI-(1), 699.
comparative, of different rails, II, 199; XI-(1), 308, 385; XII-(2), 135; XIII, 630, 635; XIV, 370, 394; XV, 204; XVI, 319.
comparative wear of Wheeler process and ordinary 75-lb. steel rails on Southern Pacific Company, II, 198.
dependent on methods of rolling, VI, 177, 180.
discussion on, XI-(1), 692, 695, 701.
laws of, XI-(1), 700-702.
of special open-hearth rails on Pennsylvania Railroad, XIII, 654.
on curves (see Curves; Rail Wear on).
on Northern Pacific Railway, XI-(1), 695.
on tangents and curves from observations on Northern Pacific Railway, XI-(1), 696-698.
progressive wear of rails, XI-(1), 359-363.
rate determined by weighing, XI-(1), 695, 704, 707.
rate of determined by rail section machine, XI-(1), 704, 708.
record of comparative wear of special rail, XIV, 393.
records of, desirable, II, 203.
revolving machine for testing rail wear, XIV, 215.

—Web

split web failures, XI-(1), 428, 445.

—Weight

affects spacing of ties, I, 151.
allowable variation in, III, 205; V, 467; XI-(1), 255.
developments in, XVI-(2), 7.
in use, 1900, II, 189.
rail failures, comparison between various weights, Bessemer, XIV, 336; XV, 208.
tonnage upon different, XIII, 847.

Rail—Continued

—Wheeler Process

comparative wear of Wheeler process and ordinary 75-lb. steel rails on Southern Pacific Company, II, 198.
description of, II, 199.

—Work on (Rails)

quality of steel affected by amount of work it receives, IX, 508.

Railway

—First American

first American railway, IV, 8.

—Crossings

(see Crossings.)

—Location

(see Economics.)

—Rack (Railways)

early opinion, V, 670.

Reagents

(see Water Service.)

Records

(see Ballast; Bridges, etc.)

Red Fir

(see Fir.)

Reinforced Concrete

(see Bridges; Buildings; Concrete, etc.)

Repair

(see Buildings, etc.)

Reports

(see Bridges; Concrete, etc.)

Resistance

—Air

dynamometer tests to determine train resistance, XI-(1), 648.
locomotive; air resistance for various velocities, XI-(1), 644.

Resistance—Continued

—Car

diagram showing observed rolling resistance of cars, XVI-(2), 288.
observations to determine rolling resistance of cars, XVI-(2), 283.
resistance in pounds per ton of cars to rolling, XVI-(2), 281.

—Curve

does elevation of curves increase train resistance, III, 82.

—Electrical

insulation resistance, megohms per mile 60 degrees Fahrenheit, one-minute electrifications, X-(1), 153; XII-(1), 70.
of treated ties, effect on track circuits, XII-(3), 429, 470.
of treated timber, XII-(3), 470.

—Friction

diagram of curves for frictional and grade resistance of railroad trains, XIII, 1161.
diagrams showing friction in cast-iron pipe, XI-(2), 1214.
flow of water in supply pipe lines and water columns for engine supply, and friction factors for same, XI-(2), 1161.
formulas and diagrams for determining loss of head through friction in pipe lines and water columns, XI-(2), 1164, 1167, 1180, 1187, 1190.

—Grade

balanced grades for helper engine service, XII-(1), 333, 334.
diagram of curves for frictional and grade resistance of railroad trains, XIII, 1161.
formula for "grade force" to overcome resistance due to grade, XIV, 605.
line resistance, XVI-(1), 107, 114.
—calculation of, XI-(1), 107, 115.
mean power at drawbar of engine on level grade, mean train resistance and differences, IX, 780.
resistance in engine rating, XIII, 1155.

—Line

formula for negative value of distance, curvature and line resistance, XVI, 118, 119.

—Locomotive

curve of engine resistance in pounds per ton, XIII, 1164.
formula of tractive force of locomotive at tender drawbar, XIII, 1153.
power of, XI-(1), 643, 644; XIV, 647.

Resistance—Continued

—Train

atmospheric, VIII, 151, 158.
coasting experiments, VIII, 155.
condition of track and equipment, XI-(1), 666; XIV, 624, 625.
defined, XII-(1), 330; XIII, 1155; XIV-(1), 589, 605; XIV-(2), 9; XV-(2), 5; XVI-(1), 107, 114.
due to curves, at high speed, XI-(1), 655.
due to curves, at slow speed, XI-(1), 656, 693.
due to curves (see Compensation for Curves), XVI-(1), 107, 108, 114.
due to grade, VIII, 150; XIV, 605.
due to long curves, XI-(1), 655.
due to short curves, XI-(1), 655.
elaborate exposition and comparison of various experiments, formulas and diagrams, VIII, 150.
formerly considered uniform at all speeds, VIII, 152.
formula for determining train resistance, V, 709; VIII, 167-178; XI-(1), 649; XII-(1), 330.
formulas and experiments, A. C. Dennis, VIII, 234, 236; XI-(1), 647, 653, 666, 686; XII-(1), 330; XIV, 612, 613, 614, 618; 1114.
—by A. K. Shurtleff, VIII, 235.
—condensed table of, VIII, 176.
formulas, Aspinall's, VIII, 162, 165, 172, 223.
—Baldwin (for high speed), VIII, 203, 205; XI-(1), 685.
—Crawford, VIII, 164, 166, 171, 224.
—recommendation of Committee, XI-(1), 653, 666; XII-(1), 330; XIV, 612, 613, 614, 618, 114; XVI-(1), 107, 114.
leaving terminal yards, XII-(1), 337, 338; XIV, 616, 1115, 1116.
less when kept moving, XIV, 616.
measuring without dynamometer car, IX, 793.
no absolute value for, XIV, 589, 1110, 1114.
of trains, VIII, 195, 236.
possibility of reducing, IX, 774.
resistance, V, 709; VIII, 149, 247; IX, 773, 774, 788, 790, 792; XI-(1), 647, 652, 653, 654, 665, 666, 685; XI-(2), 1315, 1322;
starting, V, 710; VIII, 237, 240; XI-(1), 654, 666; XII-(1), 337; XIV, 616, 1115, 1116.
starting by increments, XI-(1), 654.
starting from grade, XII-(1), 337, 338; XIV, 616.
temperature increase in cold weather, XI-(1), 666, 729; XIII, 1156; XIV, 613, 615, 616, 618.
tests, VIII, 150, 234; XI-(1), 647, 686; XII-(1), 336; XIII, 1156; XIV, 599.

Resistance—Continued

—Train

—recommendations for, VIII, 242; XI-(1), 665.
uniformity for ordinary freight train speeds, VIII, 235, 236, 238; XI-(1), 685, 716; XII-(1), 336; XIV, 1110 1114.
varying with weight of car, XI-(1), 666.

Retaining Walls

prevention and cure of slides, retaining walls, X-(2), 1024, 1028, 1091, 1100.
protection of embankments by use of retaining walls, II, 19.
(see Concrete.)

Retardation

train resistance in pounds per ton for various speeds, III, 24.
(see Resistance.)

Right-of-Way

and deed records, how arranged and cared for and what shown, II, 318, 325; VI, 651, 658, 672.
form for maps, VI, 652.
scale and what should be shown on maps, IX, 668-686.
should single or double lines be used, argument and conclusions, X-(2), 835.

Riprap

(see Embankment.)

Rise and Fall

(see Economics.)

River Gravel

(see Gravel.)

Roadbed

(see Ballast; Roadway.)

—Cross-Section

roadbed widths, narrow in cuttings, III, 15.
—and ballast, cushion between, IX, 606.
—deep cutting, I, 28.
—ditches, capacity, I, 28; II, 14, 17; IX, 606; X-(2), 922.
—widened for embankments, III, 37.
standard roadbed plans, VI, 136.
(see Ballast.)

Roadbed—Continued

—Crowning

of roadbed, III, 15; IX, 606.

—Ditches

capacity, I, 28; II, 14, 17; IX, 606; X-(2), 922.
—increased towards the outlet, I, 28; X-(2), 1095.
minimum grade for, X-(2), 1095.
side ditches, I, 28; II, 14, 17; IV, 11; IX, 606, 609, 610; X-(2), 1094, 1105; XVI, 567.
widening cut to permit, X-(2), 1095.
(see Ditches.)

—Drainage

of pockets by pipes, XVI, 599.
sub-drainage, II, 17; IV, 11, 12; VI, 150; X-(2), 920, 922, 1068, 1080, 1084, 1086, 1093, 1094, 1105; XVI, 573.
sub-drainage in cuts, excluding ditches, same as on embankments, III, 42; VI, 122.
(see Drainage.)

—Oiling

(see Ballast.)

—Pockets (in)

drainage by pipes, XVI, 599.
due to lack of full ballast, XVI, 596.
prevention and drainage of, IX, 606; X-(2), 1029, 1069, 1076, 1080, 1088, 1096; XVI, 595.
prevention by rolling sub-grade, XVI, 597.

—Pressure (on)

allowable, XIII, 388, 1021; XVI, 573, 1074.
—bibliography, XVI, 580.
classification of soils, bearing capacity, XVI, 1081.
tests made by J. R. W. Ambrose, XV, 384, 1021.
unit pressures allowable on roadbeds of different materials, XIII, 389.

—Widths

(see Cross-Section.)

Road Crossing

(see Crossings.)

Roadmaster

(see Supervisor of Track.)

Roadway

(see also Roadbed.)

—Ballast

(see Ballast.)

—Berme

for wasting, VI, 142, 172; XVI, 567.

—Bibliography

on allowable pressures on roadbed, XVI, 580.
on waterway culverts, XII-(3), 520.

—Bogs

and sinkholes, II, 15; X-(2), 1028, 1049, 1080.
counterbalancing or widening the roadbed, X-(2), 1034, 1075.
cross-laying with timber, II, 36; X-(2), 1034, 1036, 1050; XI-(2), 1064, 1087; XVI, 568.

—Borrow Pits

excavation, IV, 25; XVI, 568.
land for, at whose expense purchased, IV, 25, 34, 99.

—Bridges

(see Bridges.)

—Cables

unloading, length, size, III, 31, 52; VIII, 304, 347, 348.

—Classification

(see Excavation; Embankment.)

—Clay

burning the clay, prevention and cure of slides, I, 35; X-(2), 921, 1024, 1050, 1100.

—Clearing

and grubbing, unit of measurement, IV, 32, 33, 39, 94; VI, 123; IV, 21, 33; XI-(2), 1064.
height of stumps, IV, 21, 85.
in advance of grading, IV, 21.
—cross-sectioning, IV, 33, 87.
isolated trees, payment for, IV, 21, 40; XI-(2), 1064; XVI, 567.
removal of buildings, IV, 21; XI-(2), 1064; XVI, 567.
timber reserved, cut and piled, payment for, IV, 21, 33, 90.

Roadway—Continued

—Company Forces
company versus contract work, X-(2), 924.
for work which may interfere with operation, IX, 591, 609, 634; X-(2), 924.

—Consolidation
of embankments, outer ridge for holding rainwater, IV, 14, 97, 115.
(see Contract.)

—Core
central core by team work, III, 31; VIII, 305, 348.

—Cost
(see Cost.)

—Cribbing
sandbags, etc., II, 20; X-(2), 1052, 1066, 1076.

—Cross-Section
(see Cross-Section.)

—Crowning
(see Roadbed.)

—Culvert
(see Culvert.)

—Cuts
(see Excavation.)

—Definitions
of terms, IV, 30; V, 685, 719; VI, 138; VII, 341; X-(2), 1063; XVI, 566, 1071.

—Diagrams
acceleration and retardation curves, III, 25; V, 718.
mass diagram, VII, 395.

—Ditches
(see Ditches.)

—Drainage
(see Drainage.)

Roadway—Continued

—Dyke

David Neale Dyke System for protection of embankments, XII-(3), 533.
prevention and cure of slides by dykes, X-(2), 1025.

—Earthwork

(see Embankment; Excavation.)

—Embankment

(see Embankment.)

—Explosives

breaking up lower strata of slides with explosives, X-(2), 1090.
first use of dynamite, IV, 15.
nitro-glycerine, first use of, IV, 15.

—Filling

(see Embankment.)

—Forms

high water report form, Chicago, Milwaukee & St. Paul Railway, X-(2), 1006.
steam shovel report forms, VIII, 308, 313.

—Formulas

(see Economics.)

—Grade

(see Economics; Grade.)

—Grading

(see Embankment; Excavation.)

—Grubbing

for light fills, II, 15; IV, 33.
unit of measurement, IV, 21, 32, 33, 39, 94; VI, 123; XI-(2), 1064.

—Gullet

running a gullet through embankment first, IV, 14.

—Haul

(see Haul.)

—High Water

main track to be above, X-(2), 921, 1105; XVI, 573.
track below high water, ballast for, X-(2), 921, 1105; XVI, 573.

Roadway—Continued

—Hill Side
plowing for embankment on hill side, II, 16.

—History
historical sketch, railway location, V, 667.

—Hydraulic Methods
building embankments by, X-(2), 1074.
excavation of slides by, X-(2), 1050, 1093.

—Impact
live loads, on roadbed, XV, 1021.

—Improvements
grade and curve improvement work outside cities, III, 29; IX, 602, 603, 610.
—inside cities, III, 29; IX, 591, 602, 609.
new line avoiding interference with existing, III, 29.
of grade and alinement, I, 30; II, 20; III, 16, 29.

—Instructions
drainage areas, surveys, instructions, Chicago, Milwaukee & St. Paul Railway, X-(2), 1001, 1005.
—for embankment, II, 15; X-(2), 1105.

—Irrigation
slides caused by, X-(2), 1039.

—Labor
economics in roadway, XV, 398.

—Loading
loading of cars for unloading plows, III, 49, 53; VIII, 303, 304, 347, 348.

—Machinery
and operation, II, 22.
earthwork to be handled by, IX, 591, 609, 638.
first use of grading or road machines, IV, 15.

—Maintenance
of equipment, V, 694.
of way, V, 694.

Roadway—Continued

—Mat (Protection)

embankments, protection of, mat and revetment, along rivers, X-(2), 1023, 1041, 1053, 1054, 1060; XII-(3), 529.
reinforced concrete mattress, XII-(3), 540.

—Measurements

grading, price and measurements, IV, 25.

—Organization

for grade and curve improvement work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.
for track elevation work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.

—Overflow

anchoring track against, X-(2), 921, 1061, 1075; XVI, 573.

—Overhaul

(see Haul.)

—Payments

(see Contract.)

—Piles

(see Piles.)

—Pipes

(see Pipes.)

—Plans

side ditches, I, 28; II, 14, 17; IV, 11; IX, 606, 609, 610; X-(2), 1095.
standard roadbed plans, VI, 136.

—Plows

(see Plows.)

—Pockets

blind drains, II, 19; X-(2), 1059, 1069.
drainage by pipes, XVI, 599.
due to lack of full ballast, XVI, 596.
prevention and drainage of pockets in roadbed, IX, 606; X-(2), 1029, 1069, 1076, 1080, 1088, 1096; XVI, 595.
prevention by rolling sub-grade, XVI, 597.

—Power Drills

first use of, IV, 15.

Roadway—Continued

—Pressure
(see Roadbed.)

—Profiles
(see Profile.)

—Protection
(see Embankment.)

—Quicksand
removal of, XIII, 391.

—Reports
high water, Chicago, Milwaukee & St. Paul Railway, X-(2), 1006.
of Committee on Roadway, I, 27; II, 13; III, 14; IV, 8; V, 667; VI, 119; VII, 341; VIII, 297; IX, 589; X-(2), 919; XI-(2), 1061; XII-(3), 481; XIII, 387; XIV, 957; XV, 383; XVI, 565.
steam shovel report forms, VIII, 308, 313.

—Retaining Walls
(see Retaining Walls.)

—Revetment
protection of embankments by mat or revetment along rivers, X-(2), 1023, 1041, 1053, 1054, 1060; XII-(3), 529.

—Rock
(see Excavation.)

—Rubble
masonry, for tunnel lining, XI-(2), 1071.

—Sandbags
use of for protection of embankments, II, 20; X-(2), 1052, 1066, 1075.

—Scrapers
early use of, IV, 12.
—wheel, IV, 15.

—Sections
roadbed, II, 14; VI, 136.

—Shrinkage
horizontal, of embankments, III, 32, 46; VIII, 307, 349; IX, 608.

Roadway—Continued

—Sinkholes
and bogs, II, 15; X-(2), 1028, 1049, 1080.
counterbalancing or widening the roadway, X-(2), 1034, 1075.
crosslaying with timber, II, 36; X-(2), 1034, 1036, 1050; XI-(2), 1064, 1087; XVI, 568.

—Slag (Protection)
slides, prevention and cure, slag, II, 19; X-(2), 1039, 1045.
(see Ballast.)

—Slides
and washouts, X-(2), 1023.
breaking up the lower strata with explosives, X-(2), 1090.
caused by irrigation, X-(2), 1039.
cribbing, X-(2), 1076.
ditching, II, 15, 35; X-(2), 1106.
dykes, X-(2), 1025.
filling during construction, X-(2), 1035, 1078.
flattening the slope, X-(2), 1086, 1088, 1100.
gridiron with farm tile, X-(2), 1076, 1086.
investigating sub-strata, X-(2), 1028, 1072.
low embankments held up, X-(2), 1034.
moving of abutments, X-(2), 1051, 1076.
piles, X-(2), 1024, 1028, 1030, 1039, 1044, 1060, 1061, 1062, 1066, 1076, 1087, 1091, 1100.
prevention and cure, X-(2), 1039, 1045.
relocation of line, X-(2), 1100; XVI, 572.
removal of by hydraulic means, X-(2), 1050, 1093.
removal of top, X-(2), 1046.
riprap stone, X-(2), 1087.
sodding the slopes, X-(2), 1029, 1051, 1088.
stone filling, X-(2), 1066.
subterranean lakes, X-(2), 1073.
tunneling, X-(2), 1088, 1090.
water-softened embankment, X-(2), 1063.
weighting the toe, X-(2), 1061, 1075; XI-(2), 1064, 1087.

—Slopes
embankment slopes curved, II, 16.
flattening, X-(2), 1086, 1088, 1100.
protection of, I, 29; II, 18; XVI, 582.
sodding of, X-(2), 1029, 1051, 1088.
sodding with Japanese honeysuckle, X-(2), 1082.
—with Bermuda grass, II, 36; X-(2), 1082, 1086; XVI, 594.
—with redtop, X-(2), 1082.
stability of angle, III, 15, 34, 44; IV, 123, 125, 145.

Roadway—Continued

—Sodding
slopes, I, 29; II, 18, 36; X-(2), 1029, 1082, 1086; XVI, 582.

—Soils (Classification)
bearing capacity, XVI, 1081.
classification of, XVI, 579, 1074.

—Specifications
for Bermuda grass, XVI, 594.
for the formation of the roadway, IV, 19, 33, 111; V, 675; VI, 125, 143; XVI, 567.
for steam shovels, VIII, 298, 313, 344.

—Stumps
height of, IV, 21, 85.

—Swamps
(see Bogs; Sinkholes.)

—Tables
acceleration and retardation, III, 26; V, 718.
velocity head, III, 20.
waterway formulas and tables, XII-(3), 491-519.

—Temporary Structures
elimination of, IX, 606, 609, 610, 645.
height of fills to be built from trestles, VIII, 305, 348.
trestles, VIII, 303-347; IX, 610, 641; X-(2), 925.

—Tests
of roadbed pressure, XIII, 391, 395; XV, 384; XVI, 574.

—Timber (in Embankment)
cross-laying in bogs and sinkholes, II, 36; X-(2), 1034, 1036, 1050; XI-(2), 1064, 1087; XVI, 568.
fallen evergreen trees as fenders, X-(2), 1031.
in clearing, reserved, cut and piled, payment for, IV, 21, 33, 90.
isolated trees, in clearing, payment for, IV, 21, 40; XI-(2), 1064; XVI, 567.

—Toe of Slope
removal of, X-(2), 1101.
weighting the, X-(2), 1061, 1075; XI-(2), 1064, 1087.

—Tools
necessary to carry in steam shovel work, VIII, 300, 346; XVI, 573.

Roadway—Continued

—Track

(see Track.)

—Transporting Material

early methods of transporting excavated material, IV, 12.

Rock

(see Ballast; Excavation; Quarry.)

Roof Covering

(see Buildings.)

—Gutters

(see Buildings.)

Rope

bending stress and permissible load on wire rope bent over a sheave, XV-(2), 338.

Roundels

(see Signals.)

Roundhouse

plan of reinforced concrete roundhouse, X-(2), 1114-1117.
ventilators and smoke jacks for roundhouses, X-(2), 1125.
(see Buildings.)

Route

(see Signals.)

Rubber (Insulation)

(see Insulation; Signals.)

Rubble

(see Masonry.)

Rules

(see Ballast; Bridges, etc.)

Runoff

(see Waterways.)

Rust

(see Corrosion.)

S

Safety
of curves, V, 728; XI-(1), 668, 732.
on curves, II, 267.
signs for highway crossings, conditions of installation, II, 326.

Sand
percentage of in gravel ballast, XIV, 149, 1080.
(see Ballast; Concrete; Roadway.)

Sap
(see Lumber; Wood Preservation.)

Scale

—Boiler
(see Boiler.)

—Track
(see Track.)

—Wagon
location of in team yard, VI, 581.

Scantling
specifications for common, Douglas fir, XII-(3), 562.
—Northern pine, XII-(3), 575.
—Southern yellow pine, XII-(3), 596.
standard sizes, XII-(3), 563, 597, 599.

Scleroscope
its limitations, XI-(1), 510.
its uses, XI-(1), 494.
test of open-hearth steel, XI-(1), 503.
test of titanum, XI-(1), 510.

Scrap (Material)
care of, I, 150.
picking up, II, 293.

Scrapers
(see Roadway.)

Screening
(see Ballast; Gravel.)

Screw

—Fastenings
(see Track.)

—Lag
use of, XVI, 896.

—Spikes
(see Track.)

Seasoning
(see Ties; Wood Preservation.)

Section Foremen
(see Track.)

Segregation
(see Rail.)

Semaphore
(see Signals.)

Shale
(see Ballast.)

Shells
where available, their value and cost, V, 492; VI, 739.

Sheet Piling
plan of wooden and steel, X-(1), 569, 570.

Shingles
specifications for cypress, XIII, 875.
(see Buildings; Roof Covering.)

Shiplap
(see Lumber.)

Shoulder
(see Ballast.)

Shower Bath
(see Buildings.)

Shrinkage
(see Rail; Roadway.)

Sidetracks

(see Track.)

Signals

—Arms

placing of semaphore arms on single and double tracks, IV, 292.
position of semaphore arm, VIII, 70, 96.
references as to arm position or angle travel and continuous-light principle in signal work, III, 310.
result of letter-ballot on angle travel of semaphore arm, VII, 525.
semaphore arm or light should restrict rights, confer rights or convey information, VIII, 70; IX, 59.

—Arrangement

of signal masts, IX, 42.
standard arrangement of signals at interlocking plants, VI, 494.

—Aspects

explanation of primary, XI, 64.
signal indications and aspects, IX, 58, 66.
suggested series and fundamental principles upon which they are based, X-(1), 172, 173.
typical for method of uniform signaling, IX, 53; XI-(1), 70; XIII, 71, 75.

—Automatic Block

description and diagrams showing approved practice in 1905, VII, 505.
isolated signals, IX, 82.
requisites of installation, IX, 49.

—Automatic Train Control

findings of Committee, American Railway Association, XVI, 86.

—Bibliography

on signaling and interlocking, VI, 490.
on signaling previous to 1902, IV, 285.

—Block

automatic, showing good practice in 1905, VII, 505.
forms of manually operated telegraph; standard locations of, standard semaphore, VI, 536, 542, 543.
indicating switches right, IX, 75.
specifications for telegraph, VII, 486, 533.
standard location of telegraph, VII, 485.

Signals—Continued

—Block
telegraph and controlled manual, requisites of installation, adjuncts and description, VI, 507, 547; VII, 483.
their use in issuing orders to enginemen and conductors, IV, 293.
train order indications on block signals, IX, 83.

—Block Stations
interlocking or block stations near one another, IX, 74.

—Block System
automatic, requisites of installation, IX, 49.
controlled manual, requisites of installation, IX, 48.
electrically controlled, VI, 532.
result of letter-ballot on angle travel of semaphore arm, VII, 525.
table showing extent of use of manually operated telegraph, VI, 528.
telegraph, requisites of installation, IX, 46.
various types and locations for interlocking and automatic electric signals, VII, 507-514.

—Cables
braided, for aerial and underground use, size of wire and specifications, X-(1), 154.
compound insulated aerial braided cables for current of 660 volts or less, XII-(1), 105.
lead covered, insulated, armoured submarine cable for a 600 or lower voltage, specifications for, XII-(1), 110.
lead encased for aerial and underground use, specifications for, X-(1), 155.

—Castings
(see Castings.)

—Classification
general of signals, discussion and summary, IX, 66.

—Compensation
in pipe lines for interlocking plant, X-(1), 95.
table showing compensation for mechanical interlocking, X-(1), 96.
values of spacing "U" for given temperatures and lengths of line to be compensated in signal work, VII, 495; X-(1), 96.

—Conclusions
of Committee, VI, 506, 547; VIII, 84; X-(1), 79, 83, 222.
of the Railway Signal Association, endorsed by American Railway Engineering Association, XVI, 77.

Signals—Continued

—Confusion
possible where different kinds of signals are near together, IX, 72.

—Contract
(see Contract.)

—Controlled Manual Block
requisites of installation, IX, 48.
telegraph and, requisites of installation, adjuncts and description, VI, 507, 547; VII, 489.

—Conventional Signs
for signal work, VII, 515; XV, 81, 1009.

—Definitions
of terms, IV, 287; VI, 524; VII, 522; XI-(1), 51.

—Design
standard and specifications for material, XI-(1), 161.

—Diagrams
showing approved practice in 1905 for automatic block signals, VII, 505.
temperature diagram for spacing "U," VII, 495; VIII, 77; X-(1), 96.

—Disk
semaphore versus disk, in signaling, IX, 88.

—Distant
caution indication, IX, 81.
indications to be given by home and distant signals, IX, 86.
isolated distant signals, IX, 79.

—Drawbridge
interlocking protection of drawbridges, X-(1), 81, 145.
locking arrangement for, X-(1), 82.

—Drawings
standard, X-(1), 169, 174.

—Dwarf
signals and short range lights, IX, 94.

—Electric Control
block system, VI, 532.

Signals—Continued

—Electric Interlocking

specifications for, X-(1), 113, XI-(1), 76.
various types and locations for interlocking and automatic electric signals, VII, 507-514.

—Electric Tests

of rubber insulation, X-(1), 152; XII-(1), 103, 108, 112.

—Engine

gasoline for electric interlocking, specifications for, X-(1), 123.

—Essentials

of signaling, memorandum on, American Railway Association, XIII, 70; XIV, 72.

—Foremen

rules governing, X-(1), 54-66; XI-(1), 42; XII-(1), 61-91; XIV, 65; XV, 66.

—Forms

for wire inspector's report, XII-(1), 127.
of agreement between railroads for installing and operating an interlocking plant, X-(1), 75.

—Foundations

concrete, for an interlocking plant, X-(1), 106.
plans of signal foundations, X-(1), 107, 109.

—Four-Track Arrangement

of crossovers and slotting of interlocking signals in conjunction with automatic signals, IX, 43.

—Generator

and motor for electric interlocking, specifications for, X-(1), 124.

—Grades (on)

location of signals on ruling gradient, VIII, 253, 254.

—Historical

account of the development of signaling and use of signals, IV, 283; IX, 41.
account of interlocking in America, VI, 487.

—Home

indications to be given by home signal, IX, 85.

Signals—Continued

—Indications
basis of both primary and secondary, XI-(1), 68, 70; XIII, 71, 75.
diagram of standard signal indications, X-(1), 162, 163.
explanations of primary, XI, 64.
fundamentals of aspects and signal indications, IX, 58.
home and distant signals, IX, 86.
requisite and supplementary method of uniform signaling, IX, 47; XI-(1), 67; XIII, 71, 75.
semaphore arm or light should restrict rights, confer rights or convey information, VIII, 70; IX, 59.
to be given by home signal, IX, 85.
train-order indications on block signals, IX, 83.
used and proposed, analyzed, IX, 52.

—Indicators
requisites for switch indicators, including conveying information on condition of the block to conductors and enginemen, XVI, 75.

—Inspection
and tests of weatherproof wires, XII-(1), 116, 119, 121.
form for reporting inspection of wire, XII-(1), 127.

—Installation
pipe carriers for interlocking installation, X-(1), 94.
requisites of installation of interlocking signals, IX, 50; XI-(1), 76.
—automatic block system, IX, 49.
—controlled block system, IX, 48.
—interlocking and other signals, IX, 50, 51.
—telegraph block system, IX, 46.
track work, furnished by railroad in interlocking installation, X-(1), 89, 119.

—Insulation
(see Electric Insulation.)

—Interlocking
hand or interlocking switches, XVI, 715, 1135.
(see Systems.)

—Isolated
distant, IX, 79.
signals, IX, 82.

—Labor
in signal maintenance, XV, 71.

Signals—Continued

—Laws (State)
rules governing the construction, maintenance and operation of signals, as promulgated by the States of Illinois, Indiana, Iowa, Minnesota, Missouri and Wisconsin, XV, 93.

—Lights
discussion of continuous light and three-position principles, III, 122.
semaphore arm or light should restrict rights, confer rights or convey information, VIII, 70; IX, 59.
short range, IX, 94.

—Location
diagram illustrating location of train-order signals on different railroads, III, 306.
interlocking and automatic electric signals, VII, 507-514.
of signals on ruling gradient, VIII, 253, 254.
standard locations of block signals, VI, 536, 542, 543.
—of telegraph, VII, 485.

—Locking
arrangement for drawbridges, X-(1), 82.
facing switch point, X-(1), 82.
switches, hand or interlocking, XVI, 715, 1135.

—Low Speed
short range lights for low speed signals, IX, 94.

—Machinery
specifications for steel, X-(1), 166.

—Masts
signal, location of, IX, 42.

—Megohms
resistance, per mile, X-(1), 153; XII-(1), 70.

—Motors
specifications for, X-(1), 124.

—Orders
block signals, their use in giving orders to enginemen and conductors, IV, 293.

—Painting
an interlocking plant, X-(1), 110, 144.
(see Paint.)

Signals—Continued

—Permissive

blocking, bearing of on distinctions, IX, 71.
indications, IX, 76.

—Pipe

carriers for interlocking installation, X-(1), 94.
compensation in pipe line for interlocking plant, X-(1), 95.
line for interlocking installation, X-(1), 93.
specifications for, X-(1), 164.
table showing compensation for pipe line in mechanical interlocking, X-(1), 96.
wrought-iron, X-(1), 209.

—Plugs

specifications for, X-(1), 164.

—Primary

basis of, both primary and secondary indications, XI-(1), 68, 70; XIII, 71, 75.
explanation of primary aspects in signal indications, XI-(1), 64.

—Railway Signal Association

findings, conclusions, standards and specifications, endorsed by the American Railway Engineering Association, XVI, 77.

—Reports

form of wire inspector's report, XII-(1), 127.

—Requirements

of installation for interlocking plants, IX, 50; XI-(1), 76.

—Roundels

signals, X-(1), 167.
specifications for, X-(1), 168.

—Route

special route signaling, IX, 78, 91.

—Rubber (Insulation)

compound insulated aerial braided cables for current of 660 volts or less, XII-(1), 105.
Railway Signal Association specifications, XVI, 77.
specifications for rubber-covered wire, X-(1), 146.
tests of, X-(1), 152; XII-(1), 103, 108, 112.
wire, X-(1), 150; XII-(1), 101.

Signals—Continued

—Rules

governing the construction, maintenance and operation of interlocking plants, as promulgated by the States of Illinois, Indiana, Iowa, Minnesota, Missouri, and Wisconsin, XV, 93.
governing Supervisors of Signals, XI-(1), 39; XIV, 65.
governing Signal Foremen, X-(1), 54, 66; XI-(1), 42; XII-(1), 61, 91; XIV, 65; XV, 66.

—Secondary

basis of both primary and secondary indications, XI-(1), 68, 70; XIII, 71, 75.

—Semaphore

arm should restrict rights, confer rights, or convey information, VIII, 70; IX, 59.
castings, adopting a signal type, III, 122.
result of letter-ballot on angle travel of semaphore arm, VII, 525.
standard semaphore arm, VI, 536, 542, 543.
versus disk, in signaling, IX, 88.

—Series

suggested series of aspects and fundamental principles upon which they are based, X-(1), 172, 173.

—Slides (Glass)

specifications for, X-(1), 167, 169.

—Slotting

of interlocking signals, IX, 43.

—Specifications

cables, braided, X-(1), 154.
—lead encased, X-(1), 155.
copper clad steel line wire, XII-(1), 120.
copper line wire, XII-(1), 115.
double-braided weatherproof galvanized BB line wire, XII-(1), 117.
electrical interlocking, X-(1), 113; XI-(1), 76.
for construction of telegraph block signal and connections. VI, 519; VII, 486.
galvanized EBB iron bond wire, XII-(1), 123.
generator and motor for electric interlocking, X-(1), 124.
grey iron castings, X-(1), 164.
insulated wire, X-(1), 150.
machinery steel, X-(1), 166.

Signals—Continued

—Specifications
malleable iron castings, X-(1), 166.
material for mechanical interlocking plant, VII, 491; VIII, 73, 91; X-(1), 85; XI-(1), 76.
mineral matter rubber compound insulated aerial braided cables, XII-(1), 105, 110.
of the Railway Signal Association which have been endorsed, XVI, 77.
pipe, couplings and plugs, X-(1), 164.
roundels, X-(1), 168.
rubber-covered wire, X-(1), 146.
signal cables, X-(1), 153.
standard designs and specifications for material, X-(1), 161.
switches in electrical interlocking, X-(1), 130.
telegraph block system, VII, 486, 533.
wrought-iron bars, X-(1), 167.

—Special Route
signaling, IX, 78, 91.

—Speed
short range lights for low speed signals, IX, 94.

—Standard
agreement form for construction, renewal, maintenance and operation of interlocking plants, XI-(1), 75.
arrangement of signals at interlocking plants, VI, 494.
designs and specifications for material, X-(1), 161.
drawings, X-(1), 169, 174.
signal indications, X-(1), 163.
table of conductors, X-(1), 156; XII-(1), 125.

—Station
block or interlocking, near each other, IX, 74.

—Stop
and cautionary signals, use of for protection of unsafe and obstructed track, XIV, 68, 1038.

—Stranding
table, X-(1), 156; XII-(1), 125.

—Supervisor
rules governing, XI-(1), 39; XIV, 65.

—Switchstand
is a signal, X-(1), 80.
(see Switch.)

Signals—Continued

—Symbols

conventional signs or symbols, VII, 515; XV, 81, 1009.

—Systems

essentials, XIII, 70; XIV, 71.
of signaling, IX, 41, 87; X-(1), 159.
outline and description of a comprehensive and uniform system of signaling, XI-(1), 53, 79, 85; XIII, 70; XIV, 72.

—Tables

compensation in pipe line for mechanical interlocking, X-(1), 96.
flexible conductors, XII-(1), 126.
of conductors, standard, X-(1), 156; XII-(1), 125.
size of cables, X-(1), 154.

—Telegraph Block

and controlled manual block signals, requisites of installation, adjuncts and description, VI, 507, 547; VII, 483.
electrically controlled, VI, 532.
requisites of installation, IX, 46.
specifications, VII, 486, 533.
standard location, VII, 485.
table showing extent of use of manually operated, VI, 528.

—Temperature

diagram for spacing of "U," VII, 495; VIII, 77; X-(1), 96.

—Tests

galvanizing of steel and iron wires, XII-(1), 117, 123.
of rubber insulation, XII-(1), 103, 108, 112.
voltage tests of rubber-covered wire, X-(1), 156.
weatherproof wires, XII-(1), 116, 119, 121.

—Three-Position

discussion of three-position principles, III, 122.

—Ties

effect of creosoted ties on track circuits, XIV, 75, 1046; XV, 73.
metal, effect on track circuits, XIV, 75, 1046.
tie-plate, type for use with treated ties, XII, 410.

—Track Circuit

effect of creosoted ties on, XIV, 75, 1046; XV, 73.
metal, effect on, 75, 1046.
zinc treated ties, effect on, XIV, 75, 1046.

Signals—Continued

—Train-Order

diagram illustrating locations of train-order signals on different railroads, III, 306.
indications on block signals, IX, 83.
showing practice of roads in 1902, IV, 291.

—Trunking

standard wood, X-(1), 135, 139.

—Types

general types of signals, VIII, 86, 89.

—Uniform

outline and description of a comprehensive and uniform system of signaling, XI-(1), 53, 79, 85; XIII, 70; XIV, 72.
requisite and supplementary method of uniform signaling, IX, 47; XI-(1), 67; XIII, 71, 75.

—Units

of installation and renewal of interlocking plants, VIII, 72; X-(1), 72, 215; XVI, 85.

—Voltage

classes of construction, suggested division by voltage and by voltage and circuit, XII-(1), 203.
tests of rubber-covered wire, X-(1), 156.

—Weatherproof

copper line wire, specifications for, XII-(1), 115.
covering of wires, XII-(1), 115, 118, 120.
galvanized BB line wire, specifications for, XII-(1), 117.

—Wire

galvanized BB line wire, XII-(1), 117.
insulated, X-(1), 150; XII-(1), 101.
kerite as a covering, X-(1), 158.
rubber-covered, X-(1), 146.
size of, X-(1), 154.
specifications for EBB iron bond wires, XII-(1), 1117.
voltage tests, X-(1), 157.

—Zinc

treated ties, their effect on track circuits, X-(1), 167.

Signs

abstract of state laws regarding, V, 403.
crossing, recommended type, XV, 872.

Signs—Continued
economy of concrete and metal as compared with wood, XVI, 445-464.
instructions regarding track posts and signs, XIV, 67, 1036.
physical arrangement and placing of highway signs, II, 326.
private road crossing signs, post, board, setting, ground, letters, cost and inspection, XV, 877, 1148.
(see Crossings, etc.)

Silicon
(see Rail.)

Sinkhole
(see Roadway.)

Slab
(see Concrete.)

Slides
(see Roadway; Signals; Track.)

Slip Switches
(see Switches.)

Slipping Wheels
(see Rail.)

Slopes
(see Ballast; Roadway.)

Slow Burning
(see Buildings.)

Smoke Jacks
(see Buildings.)

Snow Fences
permanent and portable, various types of fences and substitutes described and faults and merits shown, X-(2), 881; XI-(2), 1239; XVI, 441.

—Plows
rotary and flangers, X-(2), 883-889; XI-(2), 1240; XVI, 442.

—Sheds
recommendations, XI-(2), 1241; XVI, 442.
type used on Pacific roads, X-(2), 886-893.

Soda Ash
(see Water Service.)

Soft Spots
(see Roadway; Track.)

Soils

—Bearing Power
bibliography, VIII, 47.
composing sub-grade of railroad track, XIII, 392.
roadbed pressures, classifications of soils, XVI, 579, 1074.

—Classification
particularly as to bearing capacity, XVI, 1081.

Specifications
(see Ballast; Bridges, etc.)

Speed
(see Locomotive; Signals; Curves; Economics.)

Spikes
(see Track.)

Spiral
(see Curves.)

Spreader
(see Ballast; Roadway.)

Springs
(see Car.)

Standpipe
(see Water Service.)

Staple
types used with wire fencing, V, 396.

State Laws

—Signs, Fences and Crossings
eliminating grade crossings in Chicago, I, 169.

—Track Elevation
and depression, X-(2), 919, 932.

Stations
(see Buildings.)

—Coaling
(see Coal.)

—Freight
(see Buildings.)

—Passenger
(see Passenger; Terminals.)

—Signal
(see Signals.)

—Transfer
(see Yards.)

—Water
(see Water Service.)

Steam
(see Locomotive; Wood Preservation.)

—Shovel
capacity, III, 30; VIII, 298.
cardinal points in the selection of, VIII, 298, 343.
cars for, III, 30; VIII, 302, 346; XVI, 573.
cost of steam shovel work, J. C. Sesser, VIII, 312, 324.
different for different work, VIII, 298, 343.
early use of, IV, 15.
form of report, VIII, 309-311.
getting material away from, IX, 608.
heavy work to be done by, IX, 607.
housing for employes, VIII, 300.
light traction to precede the regular work, VIII, 298, 343.
material removed by, classification for loose rock, VI, 146.
number of pitmen, VIII, 302, 346.
repair parts necessary to carry, VIII, 300, 345.
specifications for, VIII, 298, 313, 344.
track gage, III, 30; VIII, 302, 346.

Steel
(see Alloys; Bessemer; Bridges, etc.)

Stock Guards
abstract of laws of states relating to, V, 403.
cattle-guards, account of, V, 385.
definitions, V, 386, 390; XI-(2), 1231; XVI, 443.
importance, I, 168.
instructions, XIV, 68, 1037.

Stock Guards—Continued
objections to pit guards, V, 386.
practice of 62 railroads in whitewashing wing fences, XVI, 497.
ruling of railroad commission of Michigan, V, 388.
suggested specifications, V, 387, 390, 401.
wing fence, apron and cattle-guards, V, 401, 402, 442.

Stock Rail
(see Switch.)

Stone
(see Quarry; Ballast; Masonry; Excavation.)

Storehouse
(see Buildings.)

Strain (Unit)
formula for, Gordon's, VI, 205.

Stranding
(see Wire.)

Streets
concrete substructure under crossings and under tracks in paved streets, XIV, 819.
drainage under crossings and tracks in paved streets, XIV, 818.
plans for highway crossings, showing method of providing flangeway, VIII, 527-530; XIV; 818, 1176.
—for paved and unpaved streets, country roads and private or (see Crossings.)

Stremmatograph
Dr. P. H. Dudley's tests on railway track, XIV, 567.
tests of rail under service conditions, XIV, 563.

Stresses
(see Ballast; Bridges; Concrete; Masonry; Rail, etc.)

Stringers
(see Timber.)

Structures
rules governing Supervisors of, VIII, 26; XI-(1), 39; XIV, 65.
(see Bridges; Buildings, etc.)

—Permanent and Temporary
comparative economy of temporary and permanent structures, II, 73.
elimination of temporary structures, IX, 606, 609, 610, 645.
height of fills to be built from temporary trestles, VIII, 305, 348,

Structures—Continued

—Permanent and Temporary
temporary trestles, VIII, 303, 305, 337, 347; IX, 610, 641; X-(2), 925.
what constitutes permanent work, II, 73.

Stumps
height of, IV, 21, 85.
(see Roadway.)

Sub-Grade
(see Roadway.)

Sub-Strata
(see Roadway.)

Subterranean Lakes
(see Roadway.)

Subway
method of waterproofing, XV, 533.
plant for cooling the air in subways, XIV, 974, 980.
ventilation of, XIV, 958.

Sulphur
(see Ingot.)

Sump
(see Tunnel.)

Supervisors
(see Buildings; Bridges; Signals; Track.)

Supply Department (Yard)
plan of storehouse and storage yard for supply department, XIV, 1018.

Surfacing
(see Track.)

Surveys
drainage area, X-(2), 1001, 1005.
—for embankments, preliminary, II, 15.

Switch
instructions regarding, XIV, 67, 1032.
(see Frogs; Signals; Turnout.)

—Derail
plan of derail, pipe-connected to switchstand, IX, 396.

Switch—Continued

—Formula
and tables, IX, 424; X-(1), 405.
for switch leads, X-(1), 470.

—Hand
or interlocking, XVI, 715, 1135.

—Leads
points for, X-(1), 469; XI-(2), 940; XV, 593.
table of theoretical and practical, X-(1), 471-473; XI-(2), 940; XV, 593.

—Interlocking
or hand, XVI, 715, 1135.
(see Signals.)

—Points
formula for horizontal thrust at switchpoint from moving engine, XV, 586.
plan of switchpoint, XII-(1), 409.
standard switchpoints for switches, VIII, 535, 584; XIII, 372.

—Rails
height of stock and switch rail, VIII, 590.

—Slip
dimensions of double, XV, 602.
double, XV, 570; XVI, 715.
plans, Nos. 8, 11 and 16 ft., XV, 594.

—Split
formula for split switch turnout, straight points, IX, 383, 384.
—for determining the sharpest curve which a given wheel base will take, IX, 393.
—for the split switch, X-(1), 470.
plan of 16-ft. split switch, VIII, 540.

—Specifications
for switches, X-(1), 408; XI-(2), 939; XII, 403; XVI, 733, 1136.

—Stands
is a signal, X-(1), 80.
plan for facing point, VIII, 538.
switch, VIII, 535.
throw for, VIII, 535.

Switch—Continued

—Throw

of switches, XIII, 967.

—Ties

instructions regarding, XIV, 67.
plan for spacing for different lengths of switch rail, XII-(2), 404-406.
plan of spacing of ties for 16 ft. 6 in., 22 ft. and 33 ft. switches, XVI, 728.

—Types

recommended, VIII, 535.

Switching

card for switching yard records, IV, 352-354.
cut list for hump switching, XIV, 936.
report, VII, 144.
switch engine service in yards and terminals, IV, 350.
switchbacks on coal piers, V, 140.

—Engine

in yards and terminals, IV, 350.
transfer and switch engine service in yards and terminals, IV, 350.

Symbols

(see Signals; Conventional Signs.)

T

Tables

(see Abutments; Acceleration, etc.)

Talbot Process

steel, I, 129.

—Spiral

transition, II, 303.
(see Curves.)

Tamarack

as tie timber; experimental tree planting by Canadian Pacific Railway, XVI, 994.

Tamping

(see Ballast; Track.)

Tangent
adjustment of, III, 55; V, 527; VI, 753.

Tanks
(see Water Service.)

—Concrete
advantages and disadvantages of reinforced concrete for, XIII, 402.
reinforced concrete water tank, XII-(3), 339; XIII, 407-412.
reinforced, as a substructure for, XIII, 406.
specifications for, XII-(3), 334; XIII, 413.
waterproofing a reinforced concrete water tank, XII-(3), 338.

—Steel
plan of steel water tank on steel frame, XI-(2), 1157.
standpipe tanks, X-(1), 768; XI-(2), 1158; XII-(2), 353.

—Track
heating, XII-(3), 373.
in use on different roads, XIV, 902.
investigations to determine the efficiency of scoop performances, XIII, 901.
plan of fifty thousand gallon wooden storage tank, X-(1), 768; XI-(2), 1155; XII-(3), 346.
plans of, XII-(3), 369.
scoop for taking water from, XII-(3), 362; XIII, 901.
table showing sizes and data of six track pans, and average quantities of water taken out of tank and average quantity reaching engine tank, XII-(3), 358-369, 371.
tub for water tanks, sizes, hoops and fixtures, plans, etc., III, 165.

—Wood
plan of fifty thousand gallon wooden tank, X-(1), 768; XI-(2), 1155.
specifications for tank stock, Douglas fir, XII-(3), 561.
—cypress, XIII, 879, 880.

Team Tracks
delivery and freight house tracks, VI, 581.
gradient of, at freight houses, conditions affecting, III, 261, 263; XVI, 968.
in St. Louis, III, 278.
in the city of New York, III, 276.
in the city of Chicago, III, 278.

Team Tracks—Continued
in the large cities, widths of, III, 269.
plans of five freight stations, X-(1), 258-262.
roadway at team tracks, VI, 581.
spacing of, II, 43; III, 259, 260; VI, 578.

Teamways
spacing of yard tracks, suggestions regarding, II, 43; III, 259; VI, 578.

Telpherage
freight handling systems, X-(1), 273-275.
(see Freight Handling.)

Temperature
(see Rail; Signals; Tunnel.)

Tension
(see Concrete; Rail, etc.)

Terminals
(see also Yards.)

—Bibliography
of papers on yards and terminals, VI, 584; XII-(1), 261; XIII, 90.

—Bush
terminal, Brooklyn, N. Y., V, 186.

—Definitions
of terms, II, 38-46; IV, 349; V, 221; VI, 559, 568, 575, 578; VII, 153; XI-(2), 1257; XII-(1), 235, 263; XVI, 958.

—Diagram (Movement)
Belgian diagram of train movements applied to Camden Station, XIV, 914.
diagram showing occupancy of tracks and consist of trains, Kansas City Union Station, XVI, 960.
graphical diagram for use in analyzing working capacity of passenger stations, XIV, 920.
train movements at various stations, XIV, 918.

—Docks
(see Docks.)

Terminals—Continued

—Engine
(see Engine.)

—Freight Houses
(see Buildings; Freight.)

—Future Requirements
estimating future requirements for terminal property, XVI, 106, 113.

—Historical
review, IV, 348; V, 133, 206; VI, 575, 595.

—Hudson River
ventilation of tunnels, Hudson River, XIV, 981.

—Kansas City
plan of Kansas City Union Station layout, XIV, 960.

—Location
considerations governing the location of yard or cluster of yards, II, 40.
of division terminals, XVI-(1), 105, 111.
—on minor summits, XVI-(1), 105, 111.

—Passenger
(see Passenger.)

—Speed in
hump grade and speed across scales in hump yards, IX, 586.
of cars in gravity yards on Pennsylvania Lines, and changes made to secure proper, IX, 545.
provision for handling fast freight in hump yards, X-(1), 250.

Terra Cotta
(see Tunnel Lining.)

Tests
(see Ballast; Cement; Dynamometer, etc.)

Third Rail (Clearance)
clearances, XIII, 525-558.
plan of clearance line for equipment and third rail structures, XII-(1), 160, 166, 198; XVI, 927.
(see Electrical.)

Thread
(see Nuts.)

Thrust
horizontal thrust at switchpoint from moving engine, XV, 586.
(see Locomotive; Rail, etc.)

Tie-Plate
comparison of flanged and plain, XVI-(2), 303.
effect of design on durability of ties, XIV, 728; XV, 726, 745, 798, 1121.
for use with treated tie, XII, 410.
gage and tie surfacer, XVI, 553, 563.
general principles of design, XIV, 98, 1059.
imbedding beetle, XVI, 553, 562.
instructions regarding, XIV, 66, 1024.
joint, XVI-(2), 307.
joints and rails in use on German railways, XI-(2), 1346-1377.
load compression curve of rail and tie-plate, XI-(2), 830.
of Delaware, Lackawanna & Western Railroad, for use with screw-pike, XVI-(2), 306, 308.
oiling to prevent corrosion, XIV, 1061.
practice of various railways, XIV, 730.
recommended type, XI-(2), 934; XII, 410.
reducing stress on tie, X-(2), 1448.
size needed for efficient track superstructure, VIII, 55.
specifications for steel, XIV, 98, 1061.
—for wrought-iron, XIV, 99, 1062.
—malleable, XIV, 100, 1063.
tie-plates, XI-(1), 589, 621; XV, 726, 766, 798; XIV, 728, 730; XV, 728, 745, 798, 1121; XVI, 522, 553, 557, 1091.
utility of, II, 114.

Ties

—Abrasion
by track rails, III, 116; VIII, 469, 494; IX, 695; XII-(1), 395; XVI, 555.

—Adzing
ties, II, 112; VIII, 476; XV, 746; XVI, 547, 549, 550, 554, 558.

—All Track
report on ties of all tracks, II, 114.

—Beech
weight of mixed beech ties in lbs. per cu. ft. at time of treatment, XIII, 869.

Ties—Continued

—Boring

ties, II, 112; VIII, 476; XV, 727, 746, 789, 1129; XVI, 547, 549, 550.

—Climatic Effect

influence of on life, XV, 729.

—Concrete

adaptable to low speed, X-(1), 520, 532.
Affleck, VIII, 464; X-(1), 519.
Alfred, VIII, 462; X-(1), 519.
Atwood, XI-(2), 894; XII-(1), 378; XIII, 343, 357; XV, 763; XVI, 533.
Bates, XIV, 742; XV, 751; XVI, 530.
Bruckner, XII-(1), 380; XIII, 343, 357, 359, 364; XIV, 757, 761; XV, 763; XVI, 533.
Burbank, VIII, 463.
Champion (combination), XV, 757, 1135; XVI, 532.
Chenoweth, VIII, 468; X-(1), 519; XII-(1), 380; XIV, 757.
conclusions, XIII, 343, 370.
Correll, XIV, 743, 765; XV, 750.
Harrell, VIII, 461.
Hickey, VIII, 463; X-(1), 519.
illustrations of on different railroads, X-(1), 511; XI-(2), 892; XIII, 345; XIV, 742; XV, 747; XVI, 525.
index to, XVI, 536.
insulation, XV, 752.
Israel, XIII, 346.
Keefer, X-(1), 519.
Kimball, VIII, 461; X-(1), 515; XI-(2), 893; XII-(1), 384; XVI, 532.
McDonald, XIII, 365.
Percival, VIII, 746; XI-(2), 894; XII-(1), 385; XIII, 349; XIV, 754.
plans of, XIV, 743; XV, 761.
reinforced, use of abroad, VIII, 466.
report on, VIII, 460; XI-(1), 630; XI-(2), 892; XII-(1), 378; XIII, 343; XIV, 742; XV, 747; XVI, 525.
Riegler, XI-(2), 892; XIII, 343, 356; XV, 761; XVI, 532.
Sarda, VIII, 466.
Seeley, VIII, 464.
test of on Colorado & Southern Railway, VIII, 464.
—on Chicago, Burlington & Quincy Railroad, VIII, 466.
Ulster & Delaware Railroad test, VIII, 466.
(see also Manufactured.)

Ties—Continued

—Costs

a white oak tie must reach before it becomes economical to use other enumerated types, VIII, 485, 486, 487.
annual and comparative, XV, 740.
comparative value of ties of different materials, XV, 744.
cypress ties, XII-(1), 391.
equivalent, of different lengths of life, XV, 745.
formula for estimating, XV, 744; XVI, 524, 1091.
number and cost of cross-ties purchased in the United States by steam railroads, XI-(2), 764; XII-(3), 447, 450.
of creosoted ties fitted with helical linings and screw spikes, XV-(2), 295.
of maintenance, XI-(2), 889; XII-(1), 372, 378, 399; XIII, 348.
of renewals, XV, 746.
of ties, XI-(1), 581; XV, 741.
of untreated ties, II, 110; III, 102.
of untreated ties on different roads in 1900, II, 110.

—Creosoted

absorption of creosote in lbs., air-seasoned ties, XIII, 871.
boiling ties in creosote, XV, 737.
changes which take place in coal-tar creosote during exposure, IX, 738,
diagrams showing variations in weight before and after treatment, VII, 49.
Ferrell process, V, 77.
life and cost of creosoted ties in England and France, I, 82; VIII, 490; IX, 738; XV, 736.
life and cost, I, 82; II, 107, 130; VIII, 471; XV, 733.
production of in the United States, VIII, 496.
Rueping process, V, 77, 95; XI-(1), 621; XVI, 549.
specifications for, VII, 41, 44, 45, 48; VIII, 478; IX, 740, 764.
ties, I, 82; II, 107; III, 98; V, 94; VIII, 490; XV, 730; XVI, 552.
use of abroad, I, 82; IX, 738; XV, 736.
zinc-creosote process, II, 125; III, 99, 116; VI, 768; VII, 32; XI-(2), 900; XV, 737.

—Cypress

as tie timber, XII-(1), 390.
life of, V, 76.

—Dating

by boring, V, 104.
by notching, V, 101, 102.

Ties—Continued

—Dating

nails, II, 111; III, 118; V, 70, 84, 101; VII, 30, 37, 38; VIII, 494; XI-(2), 864, 903.
specifications for, VI, 767; VII, 37, 66, 67; XI-(2), 862; XVI, 552, 559.
(see Marking.)

—Decay

causes of, II, 115.
fungus growth, II, 117.
of ties, IX, 695.
(see Wood Preservation.)

—Defects

barred, V, 72, 121.

—Dimensions

of cross-ties, V, 72, 77, 126; VI, 764; VII, 29, 35, 62, 68; VIII, 459, 481, 509; XI-(2), 873; XIII, 301, 312; XIV, 769, 771, 776, 1168.
replies to inquiry regarding sizes of ties, XIII, 312.
size of cross-ties in relation to the stresses to which they are subjected, XIII, 307.
sizes of ties in use on various railroads, VI, 771.
sizes of ties in use and number used per mile, XIII, 306.

—Disposition

of old cross-ties, I, 150; II, 109.
piling, XVI, 552.
protection against fires of treated, XVI, 547.
removal of rejected, V, 131; VI, 766.
renewals in continuous stretches versus single, XIII, 332, 956.
storing of treated, XVI, 548.
taken out, fit for sidings, piled separately, I, 81.

—Distribution

and care, XVI, 538, 547, 550, 552.
and care of treated, XVI, 547.
correct number, XVI, 540.
counting and inspection, XVI, 543, 554.
disposition of old, II, 109.
loading on cars, XVI, 539.
new, good old and fuel ties, diagrams, II, 112, 113.
of steel ties, XVI, 550.
piling, II, 113; V, 74, 98, 130; VI, 765; VII, 35, 46; VIII, 476; XVI, 545, 546, 550, 552, 553.
use of work and way freight trains, XVI, 541.

Ties—Continued

—Dowels

or wood trenails, V, 76, 96; XI-(1), 601; XV, 835, 836, 838.

—Durability

life, as affected by ballast, II, 128, 129, 132; III, 97.
life, as affected by tonnage, III, 109.
life, as affected by design of tie-plates and spikes, XV, 726, 798, 1121.
life of cypress, V, 76.
life of metal, XVI, 525.
life of treated, III, 95, 98, 102; V, 66, 67, 76, 87, 93; VI, 768, 775; XI-(2), 900; XII-(1), 360; XV, 726, 733, 736, 739, 746, 798.
life of pine, V, 76.
life of, on Queensland Railways, V, 90.
life of, on Madras (India) Railway, V, 92.
life of untreated, II, 108; III, 102; V, 76, 86, 93; VI, 768; XI-(2), 900; XII-(1), 360; XV, 740, 746, 798.
life of untreated in Texas, XI-(1), 774.
life records, II, 114; III, 102; V, 76, 86; VI, 768; XI-(2), 900; XII-(1), 360.
life tests, XVI, 523.
mechanical wear, prevention of, IX, 695, 699; X-(1), 489, 494, 522.
—protection from, J. W. Kendrick, XI-(1), 581; XVI, 522, 1091. (see Wood Preservation.)

—Economics

comparative value of different cross-ties, using tie-plates, XV, 745.
comparison of different kinds of wood for ties, III, 102.
comparison of railroad ties of different material, XVI, 524.
cost a white oak tie must reach before it becomes economical to use other enumerated types, VIII, 485, 486, 487.
economy in labor and material, treated versus untreated, XV, 728; XVI, 522.
most economical cross-tie, XV, 741.
white oak economy, XV, 744.

—Experimental Track

in Texas, V, 93; VII, 31; XI-(2), 900; XII-(1), 368.

—Fastenings

for metal ties, XII-(1), 372, 377, 378, 380, 383, 385; XIII, 349, 364.
plan of metal tie on Prussian Railways, XI-(2), 1341.

Ties—Continued

—Failures
abstract of replies in regard to, VIII, 699.
causes of, VIII, 695.

—Green Timber
weakness of, XIII, 303, 311.

—Inspection
form of report of treated ties taken out of track, XVI, 561.
of cross-ties, II, 109; XVI, 554.

—Insulation
of concrete ties, XV, 752.
of metal ties, VIII, 460; X-(1), 528, 530; XII-(1), 375, 377, 384; XII-(1), 399; XIII, 343, 352, 356, 357; XIV, 760; XV, 757, 761, 762; XVI, 529, 531.
(see Electric; Insulation.)

—Laying
form of report of ties put in track, XVI, 560.
lining, II, 113.
not proper to put heart-side down, XIII, 922.

—Life
(see Durability.)

—Long
more ties to the rail, XV, 1026.
use of in roadbed, XV, 1025, 1028.

—Making
dressing and hewing, V, 72, 121; VI, 764.

—Manufactured
asphalt and metal, conclusions, XIII, 303.
combined wood and steel ties, X-(1), 511; XI-(1), 630; XI-(2), 892; XIII, 370; XV, 749.
—promise of, XII-(1), 390.
concrete (see Concrete and Steel.)
continued use of metal ties in Prussia, Switzerland, India, Mexico, South America, I, 84; VIII, 460; X-(1), 495, 520, 528; XI-(2), 876; XII-(1), 371; XIII, 343, 960; XIV, 742, XV, 747, 848; XVI, 525.
different materials, economic comparisons, XV, 741, 744; XVI, 524.
material and manufacture, V, 72, 121; VI, 764.
plans of concrete ties, XIV, 743; XV, 761.

Ties—Continued

—Manufactured

plans of steel ties, clips, stops, etc., XII-(1), 372-381; XIII, 347-369.
reaction abroad against use of metal ties, I, 82.

—Marking

cross-ties, III, 100, 112, 118, 120; VI, 767, 770; VII, 30, 38; XVI, 549.
dating by boring, V, 104.
dating by notching, V, 101, 102.
dating nails, II, 111; III, 118, 120; V, 70, 84, 101; VII, 30, 37, 38; VIII, 494; XI-(2), 864, 903.
dating, with hammer, I, 76; II, 111; III, 120.
nails, showing kinds of timber, XVI, 552.
taken out fit for sidings, piled separately, I, 81.
use of dating nails, X-(1), 617, 687; XI-(2), 748; XII-(3), 427, 434.

—Number

per mile, VII, 62; XI-(2), 870, 873; XIII, 302, 306, 331, 952; XIV, 769.

—Oak

red oak ties in Southern states, XVI, 868.

—Piling

cross-ties, II, 113; V, 74, 98, 130; VI, 765; VII, 35, 46; VIII, 476; XVI, 545, 546, 550, 552, 553.
methods of piling ties, XVI, 546, 552.
(see also Distributing.)

—Pine

life of, V, 76.

—Plates

(see Tie-Plates.)

—Records

forms for treated ties used and taken out, VI, 779; X-(1), 492; XI-(2), 865; XVI, 560.
life records, II, 114; III, 102; V, 76, 86; VI, 768; XI-(2); 900; XII-(1), 360.
life of metal ties, XVI, 525.
life, as affected by ballast, II, 128, 129, 132; III, 97.
life, as affected by tonnage, III, 109.
life, as affected by design of tie-plates and spikes, XV, 726, 798, 1121.
life tests, XVI, 523.

Ties—Continued

—Records

life of treated, III, 95, 98, 102; V, 66, 67, 76, 87, 93; VI, 768, 775; XI-(2), 900; XII-(1), 360; XV, 726, 733, 736, 738, 739, 746, 798.

life of untreated, II, 108; III, 102; V, 76, 86, 93; VI, 768; XI-(2), 900; XII-(1), 360; XV, 740, 746, 798.

rules for tie records, VI, 769; VII, 31, 38, 67.

statistics, importance of, as to renewals, I, 71; XI-(2), 865, 869, 902.

tie records, V, 85; VI, 769, 775; VII, 30, 38; X-(1), 492; XI-(2), 865, 869, 902; XVI, 523, 549, 553, 560.

tie removal forms, X-(1), 492; XVI, 560.

—Renewals

(see Records.)

—Rules

regarding cross-ties, XIII, 66.

—Seasoning

diagrams showing variations in weight before and after treatment, VII, 49.

drying before laying in track, V, 70; VII, 47, 49; XVI, 547.

drying out of treated ties, XVI, 547.

loss of weight in seasoning of ties of different woods, XI-(2), 805-811; XV-(2), 167-220.

of cross-ties, V, 68, 79; VI, 770; VIII, 476; XVI, 547.

rates of artificial air seasoning of untreated ties, XIII, 871.

tests, V, 79.

(see Wood Preservation.)

—Size

(see Dimensions.)

—Spacing

of cross-ties, I, 150.

of ties for 16 ft. 6 in., 22 ft. and 33 ft. switches, XVI, 728.

replies to questions regarding size and spacing of ties, XIII, 312.

standard tie spacing, Lake Shore & Michigan Southern Railway, XII-(3), 375, 376.

tie-spacing best adapted for roadbed pressure, VII, 103, 105.

Ties—Continued

—Specifications
for cross-ties, V, 72, 104, 120; VI, 764.
half-round, V, 77.
treated, VII, 36, 46, 66; VIII, 476; IX, 740.
untreated, VII, 35.
(see Dimensions.)

—Splitting
and crushing of yellow pine ties, XIII, 304.

—Steel
(see Manufactured.)

—Strength
bearing under rail tests, XIII, 303.
compressive strength of ties of various woods, XIII, 311.
crushing stresses of rail, X-(2), 1443.
effect of treatment on strength and durability, X-(1), 616.

—Stresses
as affecting dimensions, XIII, 301, 303; XIV, 769.
crushing stresses of rail on, X-(2), 1443.
crushing strength of woods, X-(2), 1446.
increase, XVI-(2), 13.
of spike in ties, X-(2), 1442, 1451.
relation to size, bibliography, XIII, 303, 307.

—Switch
(see Switch.)

—Tamping Future Supply IX, 715 (1908)
affects ballast, VII, 113.
how far one-sided can extend, VII, 120.
pneumatic tie tamper, XVI, 1017.
proper method, earth or sand, III, 58; V, 532; VI, 755.
—burnt clay ballast, III, 58; V, 532; VI, 756.
—chatts, gravel or chert, III, 59; V, 533; VI, 756.
—cinder ballast, III, 58, 532; VI, 755.
—stone or slag ballast, III, 59; V, 533; VI, 756.

—Tests
air dry weights of different species, XI-(2), 802.
record of service tests of treated ties, XIII, 872; XV, 634.
record of service tests of ties, XIV, 727; XVI, 856.
result of tests of cross-ties, Norfolk Southern Railway, XVI, 861.
tie removals from experimental track on Gulf, Colorado & Santa Fe Railway, XI-(2), 776-778.

Ties—Continued

—Treated

life and cost of creosoted ties in England and France, I, 82; VIII, 490; IX, 738; XV, 736.
seasoning for and after, V, 68, 97; VII, 73; VIII, 476; XVI, 547, 552.
specifications for, VII, 36, 46, 66; VIII, 476.
stamping before treating, VI, 770.
use of creosoted ties abroad, I, 82; IX, 738; XV, 736.
(see Wood Preservation.)

—Treating

(see Treating; Process; Wood Preservation.)

—Untreated

rates of artificial air seasoning of untreated ties, diagram, XIII, 871.

—Wear

mechanical, prevention of, IX, 695, 699; X-(1), 489, 494, 522.
protection from, J. W. Kendrick, XI-(1), 581; XVI, 522, 1091.

—Weight

loss of in seasoning, VII, 49.
loss of in seasoning of ties and timber of different woods, XV-(2), 167-220.
of red oak and mixed beech ties in lbs. per cu. ft. at time of treatment, XIII, 869.
variations in before and after treatment, VII, 49.
weighing ties, track scales necessary, XII-(3), 428, 459.

Tile Drains

under ballast, how placed, XVI, 1167.
(see Drainage.)

Timber

—Bending Test

cross-bending tests of red fir timbers, VI, 107.
full-sized timbers, X-(1), 594.
to determine comparative strength of woods, natural and after being treated, XI-(1), 754.

—Bridges

(see Bridges.)

—Classification

Douglas fir, XII-(3), 556.
S. M. Rowe's classification of timbers for treating, X-(1), 656.
yellow pine, XVI, 915.

Timber—Continued

—Disease

causes of decay, II, 115.
fungus growth, II, 117.
of ties, decay, IX, 695.

—Fastenings

drift bolts, round or square, VIII, 445.
for guard rails, XIV, 681, 682; XV, 403, 1036.
holes bored for spikes and bolts, VIII, 397, 398, 442, 443, 445, 446.
metal details for wooden bridges and trestles, II, 138, 140; III, 289, 297; VI, 46, 48, 49, 51; VII, 691, 704, 721; VIII, 445, 447; XI-(1), 178; XV, 1044.
use of lag screws, VII, 718; XV, 1040; XVI, 893, 1180.

—Inspection

forms for inspection of timber treatment, XIV, 715, 716.
forms for reporting treated ties taken out of track, XVI, 561.

—Life

of treated, estimated relative increase of efficiency through treatment of various woods, XI-(2), 773.
(see also Wood Preservation; Processes.)

—Piling

(see Piles.)

—Pine

(see Pine.)

—Properties

dead timber, IX, 318, 362.
knots and ring shakes, X-(1), 542.

—Report

bridge department, V, 258.
instructions, XIV, 67, 1036.

—Resources

bibliography of articles pertaining to timber resources of the United States, XIII, 435.
standing timber in the United States, XIII, 431.
timber resources of the United States, XVI, 998.

—Roadway

(see Roadway.)

Timber—Continued

—Safe Stresses
in different timber, IX, 347, 348.
safe unit stresses for timber, VII, 694.
unit for structural timber, X-(1), 564.

—Seasoning
(see Wood Preservation; Ties.)

—Strength
of tests of timbers, VIII, 418, 421.
results of tests of strength of various timbers, X-(1), 547-563.
tests of effect of steaming and preservatives on the strength of timber, VIII, 432.
tests of strength of timbers and effect of knots, VIII, 423, 429.

—Stringers
number of, V, 734, 744 (see plans of trestles.)

—Structural
Douglas fir, XII-(3), 556.
yellow pine, XVI, 915.

—Tamarack
as tie timber, experimental tree planting by Canadian Pacific Railway, IX, 990.

—Tests
compressive strength of ties of various woods, XIII, 311.
of effect of steaming and preservatives on the strength of timber, VIII, 432.
of full-sized stringers, X-(1), 594.
of Oregon fir piling, XVI-(2), 130-138.
of red fir timber, cross-bending, VI, 107.
of strength of timbers and effect of knots, VIII, 423, 429.
to determine comparative strength of woods, natural and after being treated, XI-(1), 754.

—Treating Plants
timber treating plants in the United States, IX, 737; XI-(2), 762; XII-(3), 457.

—Treatment
forms for inspection of timber treatment, XIV, 715, 716.
form for reporting treated ties taken out of track, XVI, 561.
Havelock's experiments to determine absorption of creosote, X-(1), 663.
loss of weight in seasoning of ties and timber of different woods. XV-(2), 167-220.
practice of different companies in timber treatment, X-(1), 664.
S. M. Rowe's classification of timbers for treating, X-(1), 656.

—Trestle
(see Trestles.)

—Tunnel
(see Tunnel.)

Time Book
discussion on uniform and special forms, merits and defects of each; with recommended forms for section and extra gangs, both with and without daily reports, X-(2), 837.
extra gang, what it should contain and how arranged, II, 316.

Titanium
(see Rail.)

Ton Miles
as a unit for estimating operating costs, XIV, 582, 1110; XVI-(1), 108.
equivalent ton mile on different railroads, XIV, 584.
ton mileage, ratio to total, XIV, 597.

Tonnage
(see Locomotive.)

Tool House
(see Buildings.)

Tools
(see Ballast; Bridges; Trestles.)

Track
(see also Signals.)

—Alinement
alinement and ascending grades in tunnels in same direction as prevailing winds, XV, 391.
alterations in line, grade, cross-sections, etc., claims for, XVI, 571.
compensation for curves, II, 21.
curvature, varying with radius, V, 723, 724, 726.
curves, minimum radius, early practice, IV, 9.
earnings often a controlling element in grade and alinement, III, 17.
easement curves or spiral, II, 22; V, 667.
grades and alinement, elements of economy, III, 17; IX, 608. 591, 602, 609.
grades and alignment, elements of economy, III, 17; IX, 608.
how secured, II, 252.

Track—Continued

—Alinement

insurance value of curvature, V, 728.
maintenance of line, I, 146; II, 251; III, 55; V, 527; VI, 753; X-(1), 429; XII-(1), 402; XVI, 731.
negative value of curvature, discomfort to public, V, 727.
organization for grade and curve improvement work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.

—American

experiments with English type on Pennsylvania Railroad, XIV-(2), 265.
type versus English, XIV-(2), 265.

—Anchoring

track against overflow, X-(2), 921, 1061, 1075; XVI, 573.

—Angle Bars

development to meet stresses, XVI-(2), 19.
formula for stresses in angle bars, XVI-(2), 33-44.
size of holes in, V, 536.
standard punching, IV, 515; VI, 757.
stresses in, XVI-(2), 31.
(see Track Joints.)

—Anti-Creepers

design and general requirements, XIV, 107, 1066.
necessity for with sixty-foot rails, II, 208.

—Apprentices

track, XIV, 109.

—Ballast

(see Ballast.)

—Bolts

development in, XVI-(2), 19.
principles of design, XIV, 101.
specifications for, XIV, 102, 1063; XVI, 734.
(see Rail), XVI, 406.

—Brine Drippings

from refrigerator cars; injury to signal equipment caused by, IX, 766; X-(1), 235; XII-(1), 14, 231.

—Caboose

handling of in yards, V, 133, 215.
tracks, principles of practice regarding, XII-(1), 236.

Track—Continued

—Charts
practice of railroads regarding, VII, 316.
recommended standard, VII, 278; X-(2), 734, 864, 871.
showing direction of curve on, X-(2), 871.

—Circuits
(see Signals.)

—Classification
report of special committee on Classification of Track, showing maximum weight of freight and passenger locomotives; maximum axle loads of locomotive and freight cars; maximum schedule and actual speeds of passenger and freight trains; annual train miles, passenger and freight; revenue tonnage and approximate gross tonnage; freight and passenger car mileage and per cent. of mineral, merchandise, livestock, refrigerator and fruit traffic, on different divisions of 87 railroads, upon which data classification was based, VII, 332.

—Construction
recent developments in, XVI-(2), 3.

—Curves
(see Curves.)

—Definitions
of terms, V, 527-541; VI, 748; XVI, 728.

—Depression
(see Elevation.)

—Drainage
glazed bell pipe recommended, VIII, 536, 599.
tile drains under track, how placed, XVI, 1167.
under crossings and tracks in paved streets, XIV, 818.
(see Drainage.)

—Economics
form for special record track section, XV, 595.
of track labor, XIV, 108, 1066; XV, 587, 1064; XVI, 716.
values, equating labor, XV, 590.
(see Economics.)

Track—Continued

—Elevation (Projects)

and depression work inside cities, III, 29; IX, 592-601.
bibliography, IX, 613; XVI-(2), 188.
grade crossings, elimination of, IX, 609, 610; X-(2), 926.
—state laws regarding, X-(2), 919, 926.
—states providing division of expense, X-(2), 926.
map and profile of grade elimination territory at Cleveland; New York, Chicago & St. Louis Railroad, XV-(2), 105.
organization for track elevation work, IX, 591, 608, 609, 610, 631, 646; X-(2), 923; XVI, 572.
organization for grade elimination work, New York, Chicago & St. Louis Railroad, XV-(2), 110.
plant used in grade crossing elimination work in Cleveland, XV, 113.
traffic count in various cities at grade crossings, XVI-(2), 163, 176, 210.

—Equating Values

of track labor, XV, 590; XVI, 736.

—Expansion

allowance in track, I, 131; II, 190.
proper expansion for laying rail, II, 190.

—Experimental

Texas track, V, 93; VII, 41; XI-(2), 900; XII-(1), 368.

—Fastenings

effect of screw-spike and plain, loaded and driven, on ties, XI, 596.
need not cause leakage of track circuits, XI-(2), 935.
screw- or cut-spike, X-(2), 1456.
—on the Santa Fe Railway System, X-(2), 1549.
screw-spike compared with plain, XI-(1), 596.
—on the Pennsylvania System, XV-(2), 265.
—results with on the Lackawanna Railroad, XVI,-(2), 301.
stresses in, X-(2), 1431; XIV-(2), 298.
track, I, 150; II, 281.
with treated ties, XII-(1), 410.
(see Spike.)
Helical fixings XV(2) 265 1911

—Fillers

for flangeway, I, 150; II, 283.

Track—Continued

—Foreign

native or foreign track foremen, XIV, 110.
track versus American, XIV-(2), 265.
weights and costs of different systems of track superstructure on German railways, XI-(2), 1378.

—Foremen

education; selection; duties; native and foreign, XIV, 109, 110; XV, 589, 1065.

—Formulas

and tables for frogs, rules for, IX, 424; X-(1), 405.
for turnouts, XVI, 730.

—Gage (Gauge)

affected by wheel gage, I, 153; VIII, 597; X-(1), 398.
gaging, instructions regarding, XIV, 66, 1028, 1044.
maintenance of, I, 147; II, 271; III, 59; V, 533; VII, 654; XI-(2), 934; XII-(1), 402; XVI, 732.
plan of tie-plate gage, XVI, 563.
practice of American railroads as to widening gage on curves, II, 274.
required gage for given wheel base on different curves, IX, 394, 397.
steam shovel track, III, 30; VIII, 302, 346.
track, importance of, II, 272.
—best type of, II, 272.
wide, due to worn rail, X, 398; XI-(2), 935.
widening on curves, I, 147; II, 273; III, 59; V, 534; IX, 389, 422; XVI, 733.
—formulas for, II, 276.

—Improvements

repairs and improvements, distinction between and a proposed classification of maintenance of way expenses, V, 305.

—Industrial

form of agreement for sidetrack to industries, typical, III, 398, 418.
(see Yards.)

Track—Continued

—Inspection

by roadmaster or supervisor, VII, 654.
by trackmen, II, 279.
by trackwalker, II, 278; III, 60; VI, 750; VII, 654.
form of report on track inspection, S. B. Fisher, II, 278.
rules for, I, 147; II, 278; III, 61.

—In Streets

concrete substructure under crossings and under tracks in paved streets, XIV, 819.
track construction in paved streets, X-(2), 878; XI-(2), 1238; XIV, 818, 1116; XVI, 443, 1043.

—Joints

and tie-plates, XVI-(2), 307.
picking up low, V, 533; Vl, 757.
plan of rail joints, four- and six-hole, V, 516.
plan of rail joints on German railways, XI-(2), 1346-1377.
practice as to drilling of rail joints, V, 518.
practice of railroads regarding rail section and splice bars, XV, 336.
rail, I, 150; II, 281.
requirements of a standard, VI, 747; VII, 655.
result of tests of riveted joints, VI, 284, 395.
specifications for material in, XVI, 154, 403.

—Labor

economics of track labor, XIV, 108, 1066; XV, 587, 1064; XVI, 716.
equating values, XV, 590.
form for reporting, XV, 595.

—Laying

instructions for handling, laying and relaying rail, XIII, 67, 924.
rules for ballasting, drainage, cross-section, ties, rail and surfacing, XIII, 66.

—Lead

principles regarding lead tracks, XII-(1), 236.
(see Yards.)

—Line

(see Alinement.)

Track—Continued

—Loading

capacity of track, I, 155.
diagram showing transitory depression of track under moving locomotives and cars, XIV, 569.
load compression curve of rail and tie-plate, XI-(2), 830.

—Maintenance

and operation, special structures, XVI-(1), 108.
cost of track maintenance with different types of spikes, XV-(2), 271.
experimental test of three sizes of stone ballast, giving costs of ballast and maintenance, V, 497.
formula for average expense to maintain track due to age and decay, XIV, 585.
formulas for easement curves, VII, 643-652.
maintenance expenditure per mile of line, XVI-(2), 22.
of way, V, 694.
of way and structures accounts affected by depreciation and decay, XIV, 582.
—affected by volume of traffic, XIV, 581, 1129.
—consideration of and analysis, as affecting problems of economics of railway location, V, 694; IX, 787; XI-(1), 694; XIV, 580, 1129; XV-(2), 13; XVI-(1), 108.
—due to both main and sidetrack usage, XIV, 580.
—formulas, tables and diagrams for estimating annual expense on basis of equivalent ton miles, XIV, 585, 588, 590.
—relative amount of mechanical wear caused by engines and cars, passenger and freight trains, IX, 787; XIV, 581, 582, 1129, 1131, 1134, 1135; XV-(1), 915.
rules governing, VIII, 24, 27; XI-(1), 36; XIV, 65.
the several items to be considered in operation and maintenance, II, 22.

—Material (Scrap)

care of, I, 150.
picking up scrap, II, 293.

—Men

(see Track Labor.)

—Nutlocks

specifications for spiral spring, XIV, 103.

—Nuts

thread, XIV, 1064.

Track—Continued

—Occupancy
(see Train Movement.)

—Pans
plan of, XII-(3), 359.
plan of heating layout for trackpans, XII-(3), 360.
plan of general arrangement of trackpans on Baltimore & Ohio Railroad, XII-(3), 363.
plan of circulation system and standard trackpan on the Lake Shore & Michigan Southern Railway, XII-(3), 379-386.
plan of details of trackpans and water scoop, XII-(3), 369.
plans of trackpans in use on different railroads, XIV, 902.
tests of efficiency of trackpans, XII-(3), 371.
water stations for trackpans, economics, location, etc., XII-(3), 356.
water taken into engine tank and amount lost taking water from track tank, XII-(3), 320.
(see Water Service.)

—Passenger
plan of passenger tracks and platforms in a number of cities, XI-(2), 1274-1308.
(see Yards; Passenger.)

—Passing
form of report of siding laid, extended or taken up, III, 397.
sidetrack record, XII-(3), 416.
(see Sidetracks.)

—Policing
track, I, 150.

—Profiles
(see Profile.)

—Raising
cleaning foul ballast preferable to raising track, XVI, 1167.
raising track on embankments, height of lifts, III, 31; VIII, 305, 348.

—Report
form of report of track data to Interstate Commerce Commission, V, 882.

Track—Continued

—Scales

description of scale and method of weighing, IX, 557.
grade over certain track scales, XV, 134.
hump, grade and speed across scales in hump yards, IX, 586.
in warehouses, automatic, IV, 359.
location of, in hump yards, X-(1), 250.
location of wagon scales in team yard, VI, 581.
on coal piers, V, 139.
suggested way of locating a track scale on a hump in a classifying yard, IX, 516.
table giving data of typical installations, IX, 555.

—Screw Fastenings

tie-plates for use with screw-spikes on Lackawanna Railroad, XVI-(2), 306, 308.
used in test track, XV-(2), 280, 302.
(see also Spikes; Fastenings.)

—Sidetracks

passing sidings on minor summits, XVI-(1), 105.
—and approaches, ruling gradient compensated for, XVI-(1), 105, 111.
(see Yards.)

—Soft Spots

in track (see Roadway.)

—Special Test

form for special record track section, XV, 595.

—Specifications

for crossings, XIII, 371; XVI, 727, 733.
frogs, X-(1), 408; XI-(2), 936; XII-(1), 403; XIII, 371, 375, 965; XVI, 733, 1136.
switches, X-(1), 408; XI-(2), 939; XII, 403; XVI, 733, 1136.
tie-plates, XIV, 98, 1061-1063.
track bolts, XIV, 102, 1063; XVI, 734.

—Spikes

cost of creosoted ties fitted with helical linings and screw-spikes, XV-(2), 295.
costs of track maintenance with different types of spikes, XV-(2), 271.
design of, effect on durability of ties, XV, 726, 766, 798, 1121.
effect of different kinds of spikes on timber, XV, 766.

Track—Continued

—Spikes

holding power of cut- and screw-spikes, H. B. MacFarland, XV, 790, 1122.
lateral force on spikes, XI-(2), 841, 842.
pulling test of screw-spikes, XVI-(2), 331, 334, 348.
resistance to withdrawal, XI-(2), 843.
resistance of common spikes driven into bored holes, XI-(2), 848.
—of different designs, XI-(2), 848.
result of tests as to holding power of spikes, XV, 769.
tabulation of result on treated and untreated ties to determine resistance to compression of grain and spike-pulling, XI-(2), 853.
use of lag screws abroad instead of spikes, an advantage, I, 82.
wear of spikes, VIII, 494; IX, 695.
(see Fastenings; Screws.)

—Spreading

prevented by tie-plates, I, 147; II, 272; III, 60; V, 534; XI-(1), 935.
—by rail braces, II, 272; III, 60.

—Stresses

crushing stresses of rail on ties, X-(2), 1443.
Dr. P. H. Dudley's stremmatograph tests of railway track, XIV, 567.
formulas for determining stresses in track, X-(2), 1433.
in track by locomotives on curves, X-(2), 1432.
increase wheel loads and speed, XVI-(2), 4.
of spike in ties, X-(2), 1442, 1451.
table showing some of the stresses in track by various engines, X-(2), 1440, 1443, 1455.
tie-plates reduce stress on ties, X-(2), 1448.

—Superstructure

plan of track superstructure for 60,000-lb. axle load, VIII, 56.

—Supervisors

rules governing supervisors of track, VIII, 24, 27; XI-(1), 36; XIV, 65.
(see also Track Foremen.)

—Surfacing

instructions regarding surfacing, XIII, 68, 928.
rules for ballasting, drainage, cross-section, ties, rail and surfacing, XIII, 66.

Track—Continued

—Tamping

how far one-sided can extend, VII, 120.
how pounding and tamping effect ballast, showing wear of gravel, broken stone and slag, VII, 113.
pneumatic tie tamper, XVI, 1017.
proper method, earth or sand, cinder, burnt clay, stone or slag, chatts, gravel or chert, III, 58, 59; V, 532, 533; VI, 755, 756.
tamped ballast, its supporting power compared with untamped, VII, 120.

—Tangents

adjustments of, III, 55; V, 527; VI, 753.
formulas for turnouts, XVI, 730.

—Tie-Plates

(see Tie-Plates.)

—Tie-Spacing

plan of standard tie-spacing, Lake Shore & Michigan Southern Railway, XIII, 320.
spacing of ties for 16 ft. 6 in., 22 ft. and 33 ft. switches, XVI, 728.
tabulation of practice as to tie-spacing, XIII, 312.
tie-spacing best adapted for distribution of pressure at bottom of ballast, VII, 103, 105.

—Ties

(see Ties.)

—Tools

bridge department tool report, V, 258.
description of, II, 288; III, 61.
discussion of, III, 87.
instructions as to care of, XIV, 67, 1036.
list of for section, I, 147; II, 290; III, 64; VI, 751.
—for roadmaster or supervisor of track, I, 149; II, 291; III, 65; VI, 752.
rules for ordering, I, 149; II, 292; III, 63.
steam shovel repair tools necessary to carry, VIII, 300, 346; XVI, 573.

—Turnouts

(see Turnouts.)

—Values

equating, XV, 590

Track—Continued

—Walker
inspection by, II, 278; III, 60; VI, 750; VII, 654.

—Yard
(see Yards.)

Traffic
average annual expense for age or decay due to volume of traffic, XVI, 588.
count in various cities at grade crossings, XVI-(2), 163-176, 210.
density of traffic per mile of main track of American railways, 1892-1911, XVI-(2), 8.
designing an economical plant for handling, XVI-(1), 104, 110.
estimates of II, 22; VIII, 146; XVI-(1), 105, 110, 111.
—difficulty in making, XI-(1), 694; XVI-(1), 110.
—discounting the future, VIII, 146, 148.
facilities and traffic at passenger terminals, XII-(1), 254.
grades, unequal traffic, equivalent for, V, 672.
methods of building embankments on present location under traffic, VIII, 306, 349.
tonnage in each direction to be considered, V, 672; IX, 789.
ton-mile per hour as a unit for estimating operating costs, XI-(1), 711; XI-(2), 1328, 1330, 1333.

Train
(see also Locomotive.)

—Cost (per Mile)
train-mile as a unit for estimating operating costs, XI-(1), 691, 694, 695, 711; XIII, 905; XIV, 581; XVI-(1), 107.
train-mile cost for additional train to handle a given traffic, V, 698.

—Loading
diagram showing relative economy in train loading, VIII, 195-236.
maximum train load, V, 711.
per foot of track of various cars, VI, 242.
(see Locomotive; Economics.)

—Mile
costs of train-mile, freight, V, 693, 698; XI-(1), 691.
—passenger, XI-(1), 691.

—Movement
Belgian diagram of train movements applied to Camden Station, XIV, 914.
critical analysis of working capacity of passenger terminals, XIV, 919.

Train—Continued

—Movement

graphical diagram for analyzing working capacity of passenger stations, XIV, 920.
occupancy of tracks and consist of trains, Kansas City Union Station, XVI, 960.
train movements at various stations, XIV, 918.

—Number (Maximum)

number of trains for given traffic on different ruling gradients, V, 700.

—Orders

location of train-order signals, III, 306.
signals defined, IV, 291.
train-order indications on block signaled roads, IX, 83.
(see Signals.)

—Resistance

(see Economics; Resistance.)

—Stop and Start

cost of coal consumed by a train stop, XVI-(2), 274.
formula to determine cost of stopping and starting trains, XVI-(2), 272.
time lost at stops, VIII, 249, 250, 253; IX, 775; XI-(1), 689; XIV-(2), 7; XV-(2), 9; XVI-(1), 105.
—entering and leaving sidings, VIII, 249, 250; IX, 775.

—Weight

for various gradients, V, 699.

Transfer

(see Yards.)

Transportation Expense

transportation expenses, V, 693, 694, 698, 702, 704, 706; XI-(1), 691; XIV-(2), 15; XV-(2), 14.
(see Economics.)

Transverse Fissure

(see Rail.)

Trap Rock

(see Ballast; Quarry.)

Treating Plants

(see Timber; Wood Preservation.)

Treatment
(see Ties; Timber; Water Service; Wood Preservation.)

Trees
catalpa plantation of the Illinois Central Railroad near New Orleans; an account of, XVI, 995.
dangerous, be removed, I, 150.
experiments in tree planting by railroads recounted; species planted and results, XVI, 990.
necessity for tree planting, XIII, 430.
tamarack as tie timber; experimental tree planting by the Canadian Pacific Railway, XVI, 994.
tree planting in Canada, conducted by Forestry Branch, XIII, 455; XIV, 134.
—in general, XVI, 989.
(see Conservation.)

Trespass
(see Signs.)

Trestles
bibliography, VI, 37.
cost of maintenance, II, 136, 137, 169.
cost per linear foot of creosoted ballasted trestles built in 1899 on the Santa Fe Railway System, II, 139.
embankments, filling trestles, III, 30; IV, 13, 114.
form for estimate on trestles, XI-(2), 1121.
plan of standard concrete pile trestle, XII-(1), 520, 524.
plans of pile and framed trestles, V, 732, 733, 740, 745; VI, 44.
—of ballasted deck wooden trestle, VI, 24, 52; VII, 705, 706; IX, 322, 329.
reinforced concrete trestles, some account of those in service up to 1908, X-(2), 1343.
—as protection against fire losses, XII-(2), 582.
—report on, with designs of two types, XII-(1), 517, 520, 581.
specifications for Southern bridge and trestle timbers, X, 180; XII-(3), 586.
temporary structures, elimination of, IX, 606, 609, 610, 645.
—height of fills to be built from, VIII, 305, 348.
—trestles, VIII, 303, 305, 337, 347; IX, 610, 641; X-(2), 925.
temporary trestle on the Chicago, Burlington & Quincy Railroad, VIII, 337.
(see Bridges; Timber.)

Trucking
formula for determining cost of trucking freight by different methods, XVI-(2), 234.
(see Freight.)

Trunking
(see Electric; Signals.)

Truss
(see Bridges.)

Tunnels

—Air
blow holes fitted with air valves and fans, XIV, 974, 979.
composition of air in tunnels, XIV, 959.
composition of inspired and expired air in tunnels, XIV, 961.
formula for air supply of tunnels, XIV, 965.
heat in subways, plant for cooling the air, XIV, 974, 980.

—Alinement
and descending grades in same direction as prevailing winds, XV, 391.

—American Practice
for single track tunnel sections, drawings of, XV, 392, 399.

—Bench
tunnel excavation, heading and bench at same time, XV, 392, 399.
—bench not removed until placing of wall plates, XV, 391, 399.

—Carbon Dioxide
tunnel ventilation, carbon dioxide, variations in amount of, XIV, 960, 977.

—Clearance
plan of clearance for single and double track tunnels, XI-(2), 1086.
(see Clearance.)

—Compensation
(see Grades.)

—Curves
tunnel sections, increase for curves, XI-(2), 1065, 1086; XVI, 573.
(see Curves.)

—Drainage
concrete channel, XI-(2), 1067, 1086; XVI, 573.
of tunnels, X-(2), 1094; XI-(2), 1065, 1086.
side ditches, XI-(2), 1066.
terra cotta or sewer pipe, XI-(2), 1066.
(see Drainage.)

Tunnels—Continued

—Excavation

excess outside cross-section limits, payment for, IV, 26, 34, 61.
haul and payment for, IV, 35; XVI, 570.
heading first driven entirely through, XV, 391, 399, 1031.
heading, top, XV, 391, 399.
rock, below grade, IV, 34, 100, 104; XVI, 570.
—payment for, IV, 105.
shovels, electric or air, XV, 391, 399.
various devices for excavating, hauling and dumping, VIII, 306, 348.

—Explosives

breaking up lower strata with explosives, X-(2), 1090.
dynamite, first use of, IV, 15.
nitro-glycerine, first use of, IV, 15.

—Fans

driving, XIII, 396; XIV, 625, 966, 982, 983; XV, 395, 399.
exhaustion by, XIV, 625, 966, 968, 982, 983.
ventilation, blowing against direction of train, XV, 395, 396, 399.
—blowing with direction of train, XV, 395, 399.

—Grades

compensation of grade in approach, XI-(2), 1088.
(see Grades.)

—Haul (Excavation)

various devices for excavating, hauling and dumping, VIII, 306, 348.
(see Haul.)

—Heading

tunnel excavation, heading, top, XV, 391, 399.
—and bench at same time, XV, 391, 399.
—at sub-grade, XV, 399, 1031.
—first driven entirely through, XV, 391, 399, 1031.

—Heat (in)

subways, plant for cooling the air, XIV, 974, 980.

—Hudson River

tunnels, ventilation, XIV, 981.

—Humidity

in tunnels, XIV, 976.

Tunnels—Continued

—Lining
brick, XI-(2), 1067; XVI, 573.
concrete, XI-(2), 1066.
masonry, rubble, XI-(2), 1071.
—matched ceiling, XI-(2), 1069.
reinforced concrete, XI-(2), 1072.
stone, XI-(2), 1070.
thickness, XI-(2), 1065.
timber, XI-(2), 1069.
waterproofing, XI-(2), 1070.

—Louvres
fitted with moving louvres, XIV, 979.

—Niches
niches or refuge bays in, VI, 143, 153.

—Payment
(see Contract.)

—Plant
for cooling the air, XIV, 974, 980.

—Rails (Adhesion)
damp rails, adhesion, XI-(2), 1066, 1073.

—Refuge Bays
niches or refuge bays in tunnels, VI, 143, 153.

—Reinforced Concrete
(see Lining.)

—Rock
(see Excavation.)

—Rubble
masonry for tunnel lining, XI-(2), 1071.

—Sections
American practice for single track, XV, 392, 399.
increase for curves, XI-(2), 1065, 1086; XVI, 573.
tunnel, XI-(2), 1065, 1086, 1091, 1095; XII-(3), 544; XV, 392.

—Shafts
old tunnels with shafts, XV, 1033.
payment for, IV, 35; XVI, 570.

—Slides (Tunneling)
prevention of by tunneling, X-(2), 1088, 1090.

Tunnels—Continued

—Sub-Grade
excavation at sub-grade, XV, 399, 1031.

—Sump
wells or sumps, payment for, IV, 35, 106.

—Terra Cotta
use of for drainage, XI-(2), 1066.

—Tubes
ventilation of single track tubes, XIV, 981.

—Ventilation
of tunnels, I, 31; XI-(2), 1066, 1073, 1094; XIII, 396; XIV, 625, 958.
tabulation of records of ventilation of tunnels, XIII, 398-400.
unnecessary for short, XIII, 396; XV, 395.
(see Air.)

—Waterproofing
tunnels, XI-(2), 1070.

Turnouts
classes of, XIII, 372, 965.
for split switches, various frogs, IX, 387, 425.
formulas, XVI, 730.
—for split switch turnouts, straight points, IX, 383, 384.
plan of main line turnouts, Nos. 8, 11, and 16, XIV, 132.
speed of trains through, XV, 570.
theoretical and practical switch leads, X-(1), 471-473.
track turnouts, XVI, 730.
typical plans, XIV, 132.
(see Frogs; Switches.)

Turntables
design, length and operation, showing practice of many roads, XVI, 655, 1094.
engine loads on, XVI, 664, 1094.
some requirements, VI, 684-691; XI-(2), 1024; XVI, 740.
tracks, how laid, XVI, 741.

U

Ultimate Strength
(see Bridges; Steel.)

Underwriters' Test
(see Buildings.)

Uniform General Contract
(see Contract.)

Unloading
cables, length, size, III, 31, 52; VIII, 304, 347, 348.
loading of cars for unloading plows, III, 49.
number of cars in trains, III, 31.
plows, early use of, IV, 15.
—handling of, VIII, 303, 347.
plows, III, 49, 53; VIII, 303, 304, 347; VIII, 348.
trestles (see Temporary Trestles.)
(see Ballast.)

Upsets (Bars)
(see Bridges.)

V

Valuation
act of the United States, XV, 951.
bibliography on valuation of public utilities, XV-(2), 57.

Velocity
(see Grades; Locomotive; Water Service.)

Ventilation
(see Buildings; Tunnels.)

Vertical Curves
(see Curves.)

Vibration
sharpest curve which given wheel base will take, IX, 393.
(see Bridges; Truss.)

Virtual Grades
(see Grades.)

Vulcanizing
(see Wood Preservation.)

W

Wagon
bottoms, XII-(3), 591.
in team yards, VI, 581.
measurement of trucking wagons at Chicago, III, 274
scales, location in team track, VI, 581.

Walls
(see Retaining Walls.)

Warehouse
(see Buildings.)

Washout
and slides, X-(2), 1023.
protection against, X-(2), 921, 1023, 1070, 1105.
—temporary repairs, X-(2), 1105.
—use of sandbags, X-(2), 1075.
width of opening increased, X-(2), 1105.
(see Embankment Protection.)

Watchmen
crossing, duties, when needed, II, 327.
operators and flagmen, VI, 144, 155, 158; XVI, 571.

Water Power
conditions under which it should be developed, XV, 907.

Water Service
(see also Water.)

—Analysis
of boiler water, types of plants, cost, cost of treatment, and benefits resulting, plants in service, chemical results and problems, V, 588.

—Barium Hydrate
and soda ash, comparative value as reagents, VIII, 614.
for treating engine water, advantages and disadvantages, VII, 678; VIII, 614-622.
(see Softening.)

—Bibliography
on flow of water in pipes, XI-(2), 1218.

—Boiler
(see Boilers.)

—Coaches
air and water pipes in passenger coach cleaning yard, III, 259, 260.
treated water unfit for washing coaches and windows, VIII, 620.

—Chemical
results from water softening, V, 590.
softening of water a chemical problem, VI, 599, 620.
(see Softening.)

Water Service—Continued

—Columns
flow of water in supply pipe line and water columns for engine supply, and friction factors for same, XI-(2), 1161.
formulas and diagrams for determining loss of head through friction in pipe lines and water columns, XI-(2), 1164, 1167, 1180, 1187, 1190.
loss of head in, X-(2), 1187.
plan of steel standpipe tanks, X-(1), 768; XI-(2), 1158.
specifications for reinforced concrete standpipe, XIII, 413.
tank spouts and column supply, formulas for determining elements of the latter, X-(1), 758.
tests and investigations at University of Illinois to determine friction factors in pipe lines and water columns for engine supply, XI-(2), 1161.
valve for tank or column delivery to locomotives, custom of various railroads, XI-(2), 1146.
water columns, when recommended, X-(1), 768.

—Conclusions
of Committee on Water Service, X-(1), 762; XI-(2), 1167; XII-(3), 355.

—Concrete
(see Concrete Water Tank.)

—Continuous
(see Softeners.)

—Corrosion
(see Corrosion.)

—Costs
(see Costs.)

—Definitions
of terms, V, 594-598; X-(1), 732; XI-(2), 1162.

—Design
development of design of trackpans, XII-(3), 361.

—Diagrams
for determining loss of head through friction in pipe lines and water columns, XI-(2), 1164, 1167, 1180, 1187, 1190.

—Drainage
of trackpans, XII-(3), 357.
(see Drainage.)

Water Service—Continued

—Drilling
records of strata passed should be kept of all holes, I, 55.

—Electrical Treatment
for softening water on El Paso & Southwestern System, VIII, 623; IX, 113-155.
plan of system for electrically treating water, IX, 160.

—Estimates
form for, XI-(2), 1124, 1125.

—Filtering
water, costs of plant and of doing the work, II, 232.

—Fixtures
for water tanks, III, 166; X-(1), 758.

—Flow
of water in pipes, XI-(2), 1218.
—in supply pipe lines and water columns for engine supply, and friction factors for same, XI-(2), 1161.

—Foaming
and scaling in locomotive boilers, use of compounds and mechanical agents to prevent and counteract, XVI, 686.
in boilers using treated water, VI, 599.
—reduced by treating water, VII, 668.
or priming, VIII, 615-621; XVI, 679.
rating as to incrusting and foaming ingredients, IX, 134.
(see Boilers.)

—Formulas
for determining loss of head through friction in pipe lines, XI-(2), 1164.
tank spouts and column supply, formulas for determining elements of the latter, X-(1), 758.

—Foundations
for water tanks, III, 163.
for water stations, X-(1), 746.
—cost of, X-(1), 793.

—Friction
friction factors for pipe line, XI-(2), 1161.
in cast-iron pipe, XI-(2), 1214.

Water Service—Continued

—Frostproofing

recommendation and discussion, XII-(3), 404.
water tanks, methods in use, III, 166, 167.

—Fuels

coal and gasoline compared as fuel for pumping plant, X-(1), 781.
coal and oil as fuel compared, XIII, 437.
for types of engines and pumps, XVI, 705.
steam, gasoline and air pumping discussed, II, 224; XVI, 695.
study of relative economy of different fuels for pumping stations, X-(1), 733.

—Functions

of water stations, X-(1), 746.

—General Principles

of water supply service, typical installations for various conditions, X-(1), 735.

—Geological Strata

form for recording geological strata passed through in deep wells, X-(1), 781.

—Head

loss of in feet in new straight pipe, tees and elbows; diagrams, XI-(2), 1216, 1217.
pressure from head of water, effect of valve movement on, XI-(2), 1186, 1213.

—Heat

heating trackpans, Lake Shore & Michigan Southern Railway, XII-(3), 373.
transmission through scale-covered boiler tubes, IX, 137-144, 150.

—History

of water supply on New York Central Railroad from 1840, X-(1), 794; XIII. 892.

—Impurities

effect on steam production, II, 222.
found in boiler water, scale-forming, corrosive and other, IV, 587.

—Incrusting

rating as to incrusting and foaming ingredients, IX, 134.

Water Service—Continued

—Intermittent
(see Softening.)

—Lime
and soda ash, space needed in reservoirs for reacting, VIII, 618.

—Pipes
air and water pipes in passenger coach cleaning yard, III, 259, 260.
bibliography on flow of water in pipes, XI-(2), 1218.
flow of water in, XI-(2), 1161, 1218.
formulas for determining loss of head in, XI-(2), 1164.
friction factors in pipe lines, XI-(2), 1161.
tests on at University of Illinois, XI-(2), 1161.
velocity heads, values in new cast-iron pipe, XI-(2), 1217.

—Plants
benefits from using soft water, V, 591; VII, 677; IX, 110.
—derived from use of water softening plants, VI, 601-622; VII, 668; XV, 691.
coal handling combined with water pumping and softening and other plants, economy resulting from, VIII, 281.
cost of water softening plants, V, 589; VI, 601; VII, 668.
driven wells, dug, bored and drilled, types of casing recommended, II, 221; X-(1), 736.
—description of a number on El Paso & Southwestern System, showing strata passed in drilling, analysis of water and other data, IX, 115.
experience of thirty railroads, giving costs and benefits of water softening, VI, 597.
failure of water treatment and abandonment of plant, XIV, 687.
functions of water stations, X-(1), 746.
general rules for installation and operation, XV, 688; XVI, 678.
mistakes in installing water softening plants, VIII, 619.
most economical plant for steam pumping boilers, X-(1), 740.
plan of typical water stations, foundations, frames, roofs, etc., III, 167-171.
pumping plant for location where water was secured for a number of wells at a considerable distance apart, XII-(3), 378.
size and type for various capacity, X-(1), 738-811.
water stations for trackpans, XII-(3), 356.
water stations on minor summits, XVI, 105.

—Pressure
from head of water, effect of valve movement on, XI-(2), 1186, 1213.

Water Service—Continued

—Priming
or foaming, VIII, 615-621; XVI, 679.

—Pumping
and other sources of supply discussed, II, 223.
cost for fuel for various types of pumps, XVI, 705.
cost of pumping water, II, 223.
diagram of steam pumping plants, X-(1), 785, 789.
from deep wells, its relative economy, XVI, 680.
gasoline pumps for water supply, X-(1), 770.
location of pumping plant, XII-(3), 378.
plants, size and type, X-(1), 738, 811.
report form; daily pumper's report and cost of pumping water and for record of station, X-(1), 776.
steam pumps for water supply, X-(1), 770.
steam pumps, II, 225.
—investigation into efficiency of, X-(1), 781.
table showing size of pumping plant suited to a given duty, X-(1), 763.
tests of steam and gasoline pumping plants, X-(1), 770-772.

—Reagents
rule and table for using reagent to remove foreign injurious matter from boiler water, VIII, 608.
used in softening water, VIII, 608.

—Records
form for water station record, X-(1), 778.

—Reinforced Concrete
(see Concrete; Water Tanks.)

—Repairs
to gasoline and steam pumping plants, X-(1), 774.

—Reservoirs
as source of water supply, II, 234, 235.
space needed in reservoirs for reaction of lime and soda ash, VIII, 618.

—Roofs
discussion, XII-(3), 401.
for water tanks, types described and illustrated, III, 165, 166.

—Scale
(see Boilers.)

Water Service—Continued

—Scoop

action of scoop, XII-(3), 362, 363, 364, 369, 371, 376; XIII, 892.
efficiency of scoop performances, XIII, 901.
for taking water from trackpan, XII-(3), 362; XIII, 901.

—Soda Ash

rule and table for using reagent, VIII, 608.
used in softening water, VIII, 608.

—Softening

continuous type of water softener compared with intermittent as to economy, VIII, 607.
injury to softening plant by some water, VIII, 620.
life of boilers increased and repairs reduced by use of softened water, V, 591, 592; VI, 603; XV, 693.
methods for softening water under various conditions, VI, 598; VIII, 602.
purifying waste water as a source of supply, I, 57.
result obtained from softening water, V, 589; IX, 110.
tanks for water softening, formulas for determining size, and table, VIII, 605.
types of water softeners, VIII, 603.
water softening plants, comparison of cost of installing, with benefits derived from their use, VI, 601-620; VIII, 607.
—conditions under which the installation would produce saving, VI, 608-620.

—Sources

discussion, II, 223.
purifying waste water as a source of supply, I, 57.
reservoirs, II, 234, 235.
water witches, or witch hazel guide, in locating water supply, II, 234.

—Specifications

for reinforced concrete water tank, XII-(3), 334.
—complete water station, XI-(2), 1149.
—ordinary iron or steel oil and water tanks, XII-(3), 348; XIII, 417, 984.
—standpipe, XIII, 413.
—wooden tub water tanks, X-(1), 766; XII-(3), 341.

—Spouts

tank spouts and column supply, formulas for determining elements of the latter, X-(1), 758.

Water Service—Continued

—Standpipe

steel standpipe, three plans, X-(1), 768; XI-(2), 1158, 1159.
(see Water Column.)

—Station (Types)

types of water stations used by American railroads, XI-(2), 1146.
(see Pans.)

—Supply

character of water used by 71 railroads, II, 226.
difficulties in obtaining a suitable supply of water, V, 585; IX, 114.
division terminals, water supply, XVI-(1), 105, 111.
station where supply was limited, XII-(3), 379-386.
water supply by trackpans, XII-(3), 358.

—Tanks

costs of different types of water tanks, XI-(2), 1160.
costs of pumping water, II, 223.
—of water tanks, including foundations, frame, tub—wood and steel—from ten to one hundred and sixty-five thousand gallons capacity, X-(1), 793.
fifty-thousand gallon wooden storage tank, X-(1), 768; XI-(2), 1155; XII-(3), 346.
first cost, maintenance and scrap value of seven types of wood and steel tanks, XI-(2), 1160.
fixtures for water tanks, III, 166; X-(1), 758.
—tank spouts and columns, formulas for determining elements, X-(1), 758.
for water softening, formulas for determining, size and table, VIII, 605.
foundations for water tanks, III, 163.
—cost of, X-(1), 793.
frames for supporting water tanks, plans, III, 164.
—practice of various roads, XI-(2), 1147.
frostproofing water tanks, methods in use, III, 166-177.
—recommendations and discussion, XII-(3), 404.
hoops for water tanks, width, thickness and spacing, III, 178; X-(1), 818; XII-(3), 392.
—shape and style, XI-(2), 1146.
plan of steel water tank on steel frame, XI-(2), 1157.
plan of system for electrically treating water, IX, 160.
plan of trackpans in use on different roads, XIV, 902.

Water Service—Continued

—Tanks

—of reinforced concrete water tank, XII-(3), 339; XIII, 407-412.
reinforced concrete water tanks, advantages and disadvantages, XIII, 402.
—as substructure for water tanks, XIII, 406.
roofs for water tanks, types, III, 165, 166.
—discussion, XII-(3), 401.
specifications for reinforced concrete water tank, XII-(3), 334.
specifications for wooden tub water tanks, X-(1), 766; XII-(3), 341.
—for ordinary iron or steel oil and water tanks, XII-(3), 348; XIII, 417, 984.
specifications for tank stock, Douglas fir, XII-(3), 561.
—cypress, XIII, 879, 880.
steel standpipe tanks, X-(1), 768; XI-(2), 1158; XII-(2), 353.
steel, types, size, foundations, and costs, X-(1), 755.
steel, storage, X-(1), 767, 768.
test of efficiency of trackpans, XII-(3), 371.
tub, for water tanks, sizes, hoops, fixtures, plans and details of various kinds in use, III, 165.
—its elevation, discussion and formulas, X-(1), 747.
—kind of material, roof, hoops and details, X-(1), 749, 815-817; XII-(3), 341-389.
—variety of wood for staves, XII-(3), 389.
types of water stations used by American railroads, XI-(2), 1146.
valve for tank or column delivery to locomotives, XI-(2), 1146.
water supply by trackpans, XII-(3), 358.
waterproofing a reinforced concrete water tank, XII-(3), 338.
wooden, descriptions and plans of a number of types in service on different roads, IV, 163.

—Tests

and investigation at University of Illinois to determine friction factors in pipe lines and water columns for engine supply, XI-(2), 1161.

—Trackpans

arrangement of trackpan on Baltimore & Ohio Railroad, XII-(3), 363.
circulation system and standard trackpan, Lake Shore & Michigan Southern Railway, XII-(3), 375, 376.
detail of trackpan and scoop, XII-(3), 369.
diagram showing water taken into engine tank and amount lost taking water from track tank, XII-(3), 320.

Water Service—Continued

—Trackpans

heating, Lake Shore & Michigan Southern Railway, XII-(3), 373.
scoop for taking water from trackpan, XII-(3), 362; XIII, 901.
—performances, investigations to determine the efficiency of, plan for water supply, XII-(3), 359.
trackpans in use on different railroads, XIV, 902.

—Treatment (General)

current practice as to water treatment, XV, 686.
economics resulting from treating engine water on a Western railroad, XV, 693.
failure of water treatment and abandonment of plants, XIV, 687.
failure of water treatment methods, IX, 114.
formula for determining soda ash and lime required for water treatment, VI, 618.
—for action of certain reagents used in water treatment, XVI, 689.
kinds of water used in railroad boilers, qualities and harmful ingredients, 586-597.
locomotive boiler corrosion and treated water; an account of experience of a road with, the investigation to locate cause, remedy applied and result, XIV, 420.
locomotive service bettered by water treatment, VI, 604.
methods of treatment and advantages of each, VII, 677.
proper settling capacity of tanks for water treatment, VIII, 607.
results of analysis of boiler water before and after treating, V, 590.
services of locomotives increased and needed number reduced by using better water, V, 591; VII, 668.
table showing comparison of boiler repairs, using treated and untreated water, XV, 693.
treated water unfit for washing coaches and windows, VIII, 620.
treatment of boiler water of different qualities and results obtained therefrom, IX, 110.
treatment of boiler water, analysis, types, cost of treatment and benefits resulting, plants in service, chemical results and problems, V, 588.
water supply on El Paso & Southwestern System, source of supply, quality of water, and efforts to improve, IX, 114.

Water Service—Continued

—Tub

for water tank, III, 165.
its elevation, material, etc., X-(1), 747, 749, 815, 817; XII-(3), 341, 389.
specifications for tank stock, Douglas fir, XII-(3), 561.
—cypress, XIII, 879, 880.

—Valves

for tank or column delivery, XI-(2), 1146.
movement and effect on pressure from water head, XI-(2), 1186, 1213.

—Velocity Head

for various speeds, III, 20, 26, 27.
loss of head in water columns, XI-(2), 1191, 1217.
values in new cast-iron pipe, XI-(2), 1217.

—Waste

purifying waste water as a source of supply, I, 57.

—Waterproofing

a reinforced concrete water tank, XII-(3), 338.

—Wells

deep well pumps, types, and conditions governing selections and efficiency, XIV, 882; XVI, 680.
deep, form for recording geological strata passed through, X-(1), 781.
description of a number on the El Paso & Southwestern System, showing strata passed through in drilling, analysis of water and other data, IX, 115.
driven, dug, bored and drilled, types of casing enumerated, II, 221; X-(1), 736.
pipe, layout of shallow, X-(1), 779.
pumping from deep wells, its relative economy as compared with other sources of supply, XVI, 680.

—Witch Hazel

water witches or witch hazel, some experience with as a guide in locating water supply, II, 234.

—Wooden Tank

plan for fifty-thousand-gallon, XI-(2), 1157.
(see also Tub.)

Watertown Arsenal
current testing work being done at the laboratory, IX, 480.
photographs taken at Watertown Arsenal, showing flaws in blooms and rails, IX, 480.
tests of ingots made at, XIII, 753.
tests of ingots made on shapes (derivatives), XIII, 753.
—of early English, French and German rails and of later American rails, IX, 475.
tests of splice bars and caution concerning, XII-(2), 13.

Waterways
(see Culverts.)

—Areas
area surveys, instructions regarding, Chicago, Milwaukee & St. Paul Railway, X-(2), 1001, 1005.
bibliography on determination of waterways for culverts, IX, 611; XII-(3), 520.
compilation of various formulas for waterways, XII-(3), 491.
determining the size of waterways, VIII, 312, 314; IX, 589, 611; X-(2), 920, 967, 1097; XII-(3), 482; XIII, 387; XVI, 572.
formulas and tables for determining size of openings in waterways, VIII, 314; X-(2), 967.
providing ample, IX, 606.
requisite for railroad culverts, H. W. Parkhurst, VIII, 312, 314.
run-off data, streams in the United States, XII-(3), 505.
velocity permissible, XII-(3), 500.
width of opening increased, washouts, X-(2), 1105.

—Drainage
(see Drainage.)

—Run-off
Burkli-Zeigler and McMath, X-(2), 982.
run-off data, streams in the United States, XII-(3), 505.

Wear
(see Rail.)

Weatherproofing
(see Signals.)

Weeds
cut and burn, I, 150; II, 293.

Weighing
(see Yards.)

Weights
(see Ballast; Concrete, etc.)

Wells
(see Tunnel; Sump; Water Service.)

Wheel

—Base
required gage for given wheel base on different curves, IX, 394, 397.

—Driving
(see Locomotive.)

—Flat
calibration of car springs, XI-(1), 153.
spots on car wheels injures track, rail and structures; length allowable, X-(2), 1152-1164; XI-(1), 147.
impact under cars and effect of on structures, XII-(3), 38.

—Gage
maintenance of gage affected by wheel gage, I, 153; VIII, 597; X-(1), 398.
(see Gage.)

—Load
formula for distributing wheel loads in ballast deck structures, IX, 253.
stresses increase wheel loads and speed, XVI-(2), 4.
wheel loading, various type engines, and curves of equivalence in Cooper's E loadings, XVI-(2), 302.

—Scrapers
early use of drag, IV, 12.
—wheel, IV, 15.

—Slipping
burns due to slipping of engine drivers, cause of rail failures, XI, 552.

Wheeler Process
comparative wear of Wheeler process and ordinary 75-lb. steel rails on Southern Pacific Lines, II, 198.

Whitewash
practice of 62 railroads in whitewashing wing fences of stock guards, XVI, 497.
specifications for, XVI, 518.
whitewashing or coating concrete walls, how done and advantages, V, 661.

Willow
planting of for bank protection, I, 29; II, 19.
(see Embankment; Protection.)

Wire
(see Electric; Signals.)

—Copper
electrolysis and its effect on wire, VII, 466.
properties of, XII-(1), 212-214.
table giving load and loading of hard and soft drawn, stranded and solid of different gage, XII-(1), 213.

—Fence
investigation as to ways and means for securing a proper quality, XV, 860.
kind, size, number used, etc., V, 383-397.
material needed for, V, 391.
staples used with wire fencing, V, 396.
tests of at Carnegie Institute after 3½ years' service, XVI, 505.

—Galvanized
fencing wire, VII, 454; XI-(2), 1234; XIV, 826; XVI, 440.

—Resistance
(see Electric.)

—Stranding
copper wire, XI-(1), 213.
for electrical work, X-(1), 156.

—Strength
results of tests of strength of fence wire, VII, 457.

—Stresses
formulas for catenary stresses, XII-(1), 215.

Wooden Bridges
(see Bridges.)

Wood Preservation

—Absorption
(see Creosote.)

—Air-Seasoning
(see Seasoning.)

—Allardyce Process
life of, XI-(2), 767, 768, 775; XVI, 882. (See zinc-creosote, two-injection treatment.)

Wood Preservation—Continued

—Anthracene Oil
in ether, XI-(2), 812, 816.

—Applying (Preservatives)
general principles, X-(1), 627.
open-tank process, X-(1), 629, 659.
pressure process, X-(1), 627.

—Beaumont Oil
life of, XI-(2), 770, 772.

—Bethel Process
life of, XVI, 879.

—Boiling Process
description of, XII-(3), 438.
(see Creosote.)

—Boring
(see Penetration.)

—Buehler Process
description of, XII-(3), 436.

—Burnettizing
description of, X-(1), 617, 618, 620, 630, 637, 664; XI-(2), 850; XII-(3), 455; XVI, 854, 867, 878, 880, 881.

—Carbolineum
life of, XVI, 880.

—Card Process
description of, X-(1), 657, 665; XII-(3), 435, 441; XIII, 868, 869.

—Checking
"S" irons, etc., to prevent checking, XI-(2), 738.

—Chemicals
quantity of, XI-(2), 748, 772, 813; XIII, 868.
testing for purity, XI-(2), 748.

—Coal Tar
coal tar in creosote oil, XII-(3), 427, 433; XIII, 1042; XIV, 712; XV, 626, 632, 1074; XVI, 825, 833.
creosote coal tar solution, specifications for, XVI, 826, 833.
precautions to be observed, XV, 627, 632, 1093; XVI, 827, 833.
quality of, XVI, 826, 833.

Wood Preservation—Continued

—Costs
and payments based on amount of oil used, XV, 631.
cost of creosote oil, XIII, 1043.
cost of treated and untreated cross-ties purchased in United States, kind of wood, manufacture, etc., XII-(3), 447, 450, 452.

—Creosote
(see Creosote.)

—Dating Nails
(see Dating Nails.)

—Decay
around bolt holes and places where treated wood is cut through, exposing untreated, X-(1), 633; XII-(3), 427.

—Diamond Process
life of, XVI, 879.

—Durability
effect of treatment on strength and durability, X-(1), 616.

—Emulsion Treatment
zinc-creosote emulsion treatment, specifications for, XI-(2), 741.

—English Oil
life of, XI-(2), 771, 775.

—Ether
creosote in, XI-(2), 812.

—Exposure
effect of, XV, 479.
of creosote to action of sun, X-(1), 634.

—Forms
for reporting inspection, XIII, 866; XIV, 713, 715, 716, 1165.

—Framing Timbers
and boring holes before treatment, XII-(3), 427, 445, 477.
treatment of surfaces exposed by framing after treatment, XV-(3), 478.

—Fungi
experiments in the rotting pit at Stendal, Germany, XI-(2), 812, 816.
which live on structural timber, C. J. Humphrey, XI-(2), 818.

—General Principles
for applying preservatives, X-(1), 627.

Wood Preservation—Continued

—Giussani Process
life of, XVI, 876, 879.

—Grouping (for Treatment)
of ties, tentative, for experimental preservative treatment, H. F. Weiss, XI-(2), 797.
of timber, X-(1), 623, 630, 654, 664; XI-(2), 737, 738, 750, 797; XII-(3), 441; XIII, 863, 867, 868, 1041; XIV, 711; XV, 628, 1093.

—Hasselman Process
life of, X-(1), 619; XI-(2), 768, 771, 775.

—Inspection
forms for reporting, XIII, 866; XIV, 713, 715, 716, 1165.
of timber and treatment, XI-(2), 737.

—Kyanizing Process
life of, X-(1), 618.

—Life of
creosoted ties, XVI, 881, 882. (See also under the various processes.)
of treated ties, estimated relative increase of efficiency through treatment of various woods, XI-(2), 773.

—Lowry Process
life of, X-(1), 617, 665; XI-(2), 850; XII-(3), 436; XIII, 870, 871.

—Marine Borers
creosote as protection against, X-(1), 634.

—Mechanical Wear
narrow tie plates, XVI, 855, 858.
of ties, X-(1), 617, 630, 635; XI-(2), 737, 775; XIII, 1045; XVI, 855, 858, 860, 883, 884.

—Methods
(see Various Processes.)

—Microscopic Data
microscopic structure and physical condition of wood as affects penetration by preservatives, H. D. Tiemann, X-(1), 638.
microscopic slits in seasoned timber, XI-(2), 786, 791.

—Open Tank Process
methods, X-(1), 629, 659.

Wood Preservation—Continued

—Payments

to be based on amount of oil used, XV, 631.
(see Contract.)

—Penetration

borings to test, XI-(2), 748, 860.
depth of, X-(1), 628, 629, 659, 660, 664; XV, 631.
physical structure of wood as to penetrability by preservative fluids, H. D. Tiemann, XI-(2), 781.

—Permeability

effect of the structure of wood upon its permeability, I. W. Bailey, XVI, 833, 835.

—Petroleum

life of crude, XI-(2), 752, 767, 769, 772; XVI, 880.
tar creosote, XI-(2), 753.

—Piles

(see Piles.)

—Plants

(see Treating Plants.)

—Pressures

air pressure, time, X-(1), 660, 664.
applying pressure process, X-(1), 627.
on solution, time, X-(1), 627, 628, 660, 661, 662, 664; XI-(2), 742.
steaming, pressure, time, X-(1), 628, 637, 654, 657, 664; XI-(2), 738, 768.

—Records

daily reports of treatment, XI-(2), 748.
necessity for, X-(1), 617, 630, 637.

—Reports

of Committee on Wood Preservation, X-(1), 615; XI-(2), 735; XII-(3), 425; XIII, 863; XIV, 711; XV, 625; XVI, 825.
—discussions, X-(1), 669; XI-(2), 858; XII-(3), 477; XIII, 1039; XIV, 1165; XV, 1073; XVI, 1152.

—Resistance

electrical, of treated ties, XII-(3), 429, 470. (See effect of treated ties on track circuits.)
—of treated timber, J. T. Butterfield, XII-(3), 470.
screw-spikes, XI-(2), 848. (See holding power of screw-spikes.)

Wood Preservation—Continued

—Rotten Wood
to be kept away from yards, XI-(2), 738.

—Rueping Process
creosoting, life of, X-(1), 617, 660, 664; XI-(2), 850; XII-(3), 439; XIII, 872; XVI, 870.

—Rutgers Process
life of, XI-(2), 816.

—"S" Irons
use of to prevent checking, XI-(2), 738.

—Salt Treatment
common, XI-(2), 816.

—Sapwood
no objection in piles and timber to be treated, XII-(3), 444.

—Seasoning
microscopic slits in seasoned timber, XI-(2), 786, 791.
of timber, XI-(2), 737, 738, 751, 802, 858; XIII, 871.
ties, rates of, XI-(2), 804; XIII, 871; XVI, 868.
—diagrams, XI-(2), 805.

—Silicate (Sodium)
sodium fluor-silicate, XI-(2), 816.

—Specifications
creosote coal tar solution, XVI, 826, 833.
for analysis of creosote oil, XI-(2), 743.
for piles and timber to be treated, XII-(3), 428, 443.
fractionation of creosote oil, XII-(3), 432; XIII, 866; XIV, 713, 717, 1165; XVI, 872.
No. 2 grade creosote oil, XIII, 865, 1042.
No. 3 grade creosote oil, XIII, 865, 1043.
plain creosoting, XI-(2), 740.
standard for creosote oil, X-(1), 621, 673; XI-(2), 737; XII-(3), 430; XIII, 865.
tie treatment, XI-(2), 737.
zinc-chloride, X-(1), 621, 670; XI-(2), 739.
zinc-creosote emulsion treatment, XI-(2), 741.
zinc-tannin treatment, XI-(2), 739.

—Specific Gravity
of creosote oil, XII-(3), 430, 433; XIII, 1049.

Wood Preservation—Continued

—Spikes (Resistance)

of common spikes driven into bored holes, XI-(2), 848.
of screw-spikes, XI-(2), 848.
strength of treated timber; tests of strength of treated ties; holding power as to spikes, W. K. Hatt, XI-(2), 827, 853; XII-(3), 467.

—Statistics

experience of various roads with different methods of treatment, X-(1), 618.
of cross-ties purchased, number, cost, kinds of wood, per cent. treated in 1907, 1908, 1909, XI-(1), 764; XII-(3), 447, 450.
record of tie service tests, XIII, 872, 1040; XIV, 714, 726; XV, 627, 634; XVI, 833, 854, 855, 856, 865, 867, 875, 878, 881.
timber treatment, X-(1), 617; XI-(2), 748, 764; XII-(3), 446.

—Steaming Process

pressure, time, X-(1), 628, 637, 654, 657, 664; XI-(2), 738, 786.
strength of timber, excessive heating, XI-(2), 759, 760.
when necessary, X-(1), 637; XI-(2), 739.

—Strength

effect of temperature, XI-(2), 855.
effect of treatment on strength and durability of timber, X-(1), 616.
strength of ties treated with crude oil, W. K. Hatt, XII-(3), 467.
strength of treated timber, high solutions of zinc-chloride, XI-(2), 760.
—heavily creosoted weak in compression at right angles to grain, XI-(2), 760.
tests of, XI-(2), 754, 756, 827; XII-(3), 428.
treated timber, X-(1), 616, 623, 625, 630; XI-(2), 754, 756, 825, 827, 833; XII-(3), 428, 467.
zinc-chloride, etc., strength of solution to be varied, XI-(2), 748.

—Summerwood

characteristics, XVI, 842.

—Tanks

general principles of open-tank process, X-(1), 627.
storage tanks, XVI, 832, 833.

—Tannin Process

Allardyce, life of, XI-(2), 767, 775; XVI, 882.

Wood Preservation—Continued

—Tar

creosote oil from water gas tar, XIV, 712; XV, 625.
petroleum tar creosote, XI-(2), 753.
treatment, XI-(1), 618.
(see Coal Tar.)

—Temperature

effect of on the strength of ties treated with crude oil, XI-(2), 885.
—on timber, X-(1), 664; XI-(2), 740, 742, 885.

—Tests

borings to test penetration, XI-(2), 748, 860.
chemicals, testing for purity, XI-(2), 748.
creosote distilling test, XII-(3), 430.
—apparatus for, XII-(3), 430.
record of tie service tests, XIII, 872, 1040; XIV, 714, 726; XV, 627, 634; XVI, 833, 854, 855, 856, 865, 867, 875, 878, 881.

—Thilmany Process

life of, XVI, 854, 880.

—Ties

cross-ties treated in United States, 1907, 1908, 1909, XII-(3), 455.
drying after treatment, X-(1), 637; XI-(2), 748.
electrical resistance of treated ties, XII-(3), 429, 470.
grouping, tentative, for experimental preservative treatment, H. F. Weiss, XI-(2), 797.
life of zinc-treated, XI-(2), 748.
precautions to be observed in Burnettizing ties, X-(1), 637.
seasoning, rates of, XI-(2), 804; XIII, 871; XVI, 868.
—diagrams, XI-(2), 805.
statistics of cross-ties purchased, XI-(2), 764; XII-(3), 447, 450, 452.
supply and consumption, XI-(2), 749.
tie treatment specifications, XI-(2), 737.
track scales a necessity for weighing ties, XII-(3), 428, 459.
(see Ties.)

—Vacuum

inches of time, X-(1), 637, 654, 657, 664; XI-(2), 738.
preliminary on air-seasoned ties, XI-(2), 858.

—Vulcanizing

life of, XVI, 859, 862, 880.

Wood Preservation—Continued

—Zinc-Chloride

Burnettizing, X-(1), 617, 618, 620, 630, 637, 664; XI-(2), 850; XII-(3), 455.
drying after treatment, X-(1), 637; X-(2), 748.
life of, XI-(1), 617, 618; XI-(2), 748, 767, 769, 771, 775, 816; XVI, 854, 867, 878, 880, 881.
precautions to be observed, X-(1), 637.
quantity injected, X-(1), 617, 637, 664; XI-(2), 739.

—Zinc-Creosote

and Beaumont oil, life of, XI-(2), 770, 772.
English oil, life of, XI-(2), 771, 775.
Giussani process, life of, XVI, 879.
heavily creosoted weak in compression at right angles to grain, XI-(2), 760.
high solutions of, XI-(2), 760.
life of, X-(1), 617, 619; XI-(2), 767, 771; XVI, 879, 881.
specifications for, X-(1), 739.
specifications for two-injection treatment, XI-(2), 742; XII-(3), 435.
supply and consumption, XI-(2), 749.

—Zinc-Tannin

quantity injected, XI-(2), 740.
specifications, XI-(2), 739.
Wellhouse process, life of, X-(1), 618; XI-(2), 748, 767, 770, 771, 775, 816; XVI, 859, 860, 862, 880.

Worm Defects

(see Lumber.)

Y

Yards

(see also Buildings; Terminals; Track.)

—Bibliography

on yards and terminals, VI, 584; XII-(1), 261; XIII, 90.

—Capacity

car capacities of freight yards, Pennsylvania Lines, Southwest System, IX, 546.

—Car Cleaning

type of car cleaning yards, III, 268.

Yards—Continued

—Classification

gradient for classification yard, steeper needed in winter than in summer, with plan for accomplishing, IX, 522, 578.
yard, essential requirements to be met, II, 42.

—Cluster

for rail and water terminal, suggestions as to requirements, IV, 357.
or general yard, plan of, III, 258, 268.
types, III, 268.

—Coach Yard

air-brake testing plant, discussion of proper location, IX, 573.
air and water pipes in coach cleaning yard, III, 259, 260.
passenger coach and car cleaning yard, requirements, III, 260, 268.
staging in car cleaning yard, III, 260.
suggested principles, III, 260, 268; XII-(1), 236.

—Conclusions

of Committee on Yards and Terminals, III, 267; IV, 370; V, 182-222; VI, 561, 570, 578; VII, 152, 156; IX, 540, 542, 572; XII-(1), 240; XIII, 93, 947; XIV, 924, 937; XVI, 958, 1190.

—Conveyors

for handling baggage and mail, XV, 112.
for handling express and parcels, XV, 115.
mechanical, for handling freight on steamship docks, IX, 535; XIV, 953.

—Cost (of Service)

cost of moving cars through hump yards compared with poling and push and pull methods, VI, 576; IX, 583; XVI, 986, 1190.
investigation of methods and costs of freight handling in freight houses, XV-(2), 363; XVI-(2), 242.

—Cranes

overhead traveling crane needed in freight houses, III, 262-265.
overhead jib crane, description of type used in freight houses in Great Britain, XIV, 953.
types of cranes and derricks in use on piers, IV, 361.

Yards—Continued

—Curves

allowable curvature on throat tracks at stations, XIV, 1092.
curvature which will hinder the coupling of passenger coaches, XIV, 1091.
difficult to couple passenger coaches on curves sharper than six degrees, XIV, 1091.
maximum curvature on tracks where passenger coaches are coupled, XIV, 1091.
of short radius and on heavy grades operated by geared locomotive, XVI, 968.
radius of curves operated over by passenger trains in terminals, XI-(2), 1251.

—Cut List

and other systems for indicating destination of cars to towerman, XV, 142.
use of recommended in hump yards, XIV, 937, 1095.

—Definitions

of terms, II, 38-46; IV, 349; V, 221; VI, 559, 568, 575, 578; VII, 153; XI-(2), 1257; XII-(2), 235, 263; XVI, 958.

—Derrick

derrick on lighters at water terminals, IV, 361.
for handling freight at terminals, XII-(1), 247.
types of derricks used on piers, IV, 361.

—Design

design of hump yards on Pennsylvania Lines; capacity, etc., IX, 545.
—and operation of hump yards at Centralia and Godfrey, XIV, 935.
—and operation of yard at Winnipeg, XV, 128.
development in design and operation of hump yards, XVI, 968, 978.
is a departure yard desirable, XV, 146.
yard for passenger traffic at medium-sized station, stub and through, typical plans, XII-(1), 237-240.
—for holding passenger cars, XIV, 1090.

—Diagrams

Belgian diagram of train movements applied to Camden Station, XIV, 914.
graphical, for use in analyzing working capacity of passenger stations, XIV, 920.

Yards—Continued

—Divisional

terminal at tidewater, VI, 584.
terminal yard, essential requirements, with plans, III, 266-268.
type of division terminal yard, III, 268.

—Docks

(see Docks.)

—Driveways

in yards at freight houses in nine large cities, width of, III, 269.
roadways for teams at freight houses, III, 262, 264, 268, 269.
—at team tracks, VI, 581.

—Elkhart

plan of Elkhart yard, Lake Shore & Michigan Southern Railway, VII, 134.

—Galesburg

plan of freight yard at Galesburg, Ill., Chicago, Burlington & Quincy Railroad, X-(1), 284.

—General Yard

at rail and water terminal, IV, 357.

—Grades

advisable gradients in hump yards, I, 23; VI, 578; VII, 138, 157, 180; XIV, 937.
for classification yard, steeper in winter than in summer, IX, 522, 578.
gradient of team tracks at freight houses, conditions affecting, III, 261-263; XVI, 968.
—in gravity yards, I, 23; VI, 578; VII, 138, 157, 180; IX, 516, 524, 545; XIV, 937.
—of industry tracks which may be worked by geared engines, XV, 968.
—of streets in business districts of nine large cities, III, 269.
—over track scales, approach and leaving, IX, 520, 526, 555, 556, 576; XV, 134, 1018.
of tracks on coal piers, V, 140.
(see Grades.)

—Gravity

construction of hump in gravity yards, VIII, 515.
grades in gravity yards, I, 23; VI, 578; VII, 138, 157; VII, 180; IX, 516, 524, 545; XIV, 937.

Yards—Continued

—Gravity

practice in weighing on gravity hump, IX, 577.
speed of cars in gravity yards on Pennsylvania Lines, and changes made to secure proper, IX, 545.
track scales in gravity yards, VIII, 516, 525, 579; IX, 525, 555, 576; X-(1), 249; XV, 136, 1018.
when first used, IV, 348; V, 133; VI, 595.
(see Hump.)

—Historical

review on yards and terminals, IV, 348; V, 133, 206; VI, 575, 595.

—Hold

expense and trouble in handling "hold cars," IV, 350.
holding yard for passenger cars, XIV, 1090.

—Hump

advisable gradients in, I, 23; VI, 578; VII, 138, 157, 180; XIV, 937.
conveying car riders back to hump, IX, 526; XV, 138.
comparison of operating conditions in one hump and two flat yards, XVI, 986.
construction of in gravity yards, VIII, 515.
cost of moving cars, comparisons, VI, 576; IX, 583; XVI, 986, 1190.
design and operation, Centralia and Godfrey, Illinois Central Railroad, XIV, 935.
development in design and operation, XVI, 969, 978.
grade and speed across scales, IX, 586.
grades in hump yards, VII, 167.
indicating destination to towermen, XV, 142.
list of hump yards, X-(1), 320; XV, 133.
location of scales, handling fast freight, X-(1), 250.
on Pennsylvania Lines, design, capacity, etc., IX, 545.
—Winnipeg, XV, 128.
some merits of, VII, 173.
suggestions for locating track scales on a hump in a classification yard, IX, 516.
switching tests to determine acceleration and distance, IX, 554.
typical, description of and operation, VII, 130; IX, 522, 543, 545.
when first used, IV, 348; V, 133; VI, 595.
(see Gravity.)

Yards—Continued

—Inclines

coal piers with locomotive incline, V, 135-137.
—having inclined plane and berth on one and both sides, V, 136, 137.
inclined plane for coal piers, its advantages, method of working, etc., V, 141.
—compared with switching, V, 142.

—Industrial

district yards, III, 266.
tracks, seven per cent. grade, sharp curves worked by geared engine, XVI, 968.
type of, III, 268.
(see Contract; Track.)

—Interchange

improvements in handling of interchange freight at freight terminals, to avoid congestion, XII-(1), 256.
need of freight yards for interchange traffic, XII-(1), 241.

—Lead

tracks, principles of practice, XII-(1), 236.

—Lighting

freight houses, suggestions, III, 262-265.
warehouses on piers, windows and artificial, IV, 359.
yards, the problem stated, IX, 528.
—recommendations, IX, 541.

—Location

of division terminal, XVI-(1), 105, 111.
of yard or cluster of yards, considerations governing, II, 40.
on minor summits, XVI-(1), 105, 111.

—Movements

of cars into and through yards, and records of cars, IV, 350.

—Operation

comparison of operating conditions in one hump and two flat yards, XVI, 986.
problems in planning and operating yards, general discussion. I, 17; II, 43.
—in planning and arranging freight stations and moving freight through station, XV-(2), 363; XVI, 963.

Yards—Continued

—Piers
(see Piers.)

—Pipes (Air)
in freight car repair yard, and passenger coach cleaning yard, III, 259, 260.

—Plan
of cluster or general yard, III, 258, 268.
of freight car repair yard, III, 259, 268.
of passenger terminal, stub and through type, with track layouts, XII-(1), 237-240.
of yards, IV, 355.
problems in planning and operating yards, I, 17; II, 43.

—Poling
cars add to efficiency of yards, XV, 1020.

—Ramps
required at tidewater terminals, IV, 359.

—Receiving
yard, consideration of factors controlling location and design, II, 41.

—Records
of movements of cars through yards, IV, 350.
of terminal switching, IV, 349.

—Repair Yards
freight car repair yards, arrangement, spacing, length of tracks, and plan, III, 259-268; VI, 578-580.
—shed over, VII, 171.
material supply, its location in freight car repair yards, III, 259.

—Riders
car riders in gravity yards, methods for conveying back to hump, IX, 526; XV, 138.
determining number required to handle cars over hump, XV, 138.

—Scales
data of typical installations, IX, 555.
description and method of weighing, IX, 557.
grade and speed across scales in hump yards, IX, 586.
grade over certain, XV, 134.
in warehouses, automatic recommended, IV, 359.
location of scales, handling fast freight, X-(1), 250.

Yards—Continued

—Scales

location of track scales on hump in classification yard, IX, 516.
on Duluth & Iron Range Railroad, IX, 556.
track scales on coal piers, V, 138.
track scales in yards, location of, VI, 579.
track scales in gravity yards, VIII, 516, 525, 579; IX, 525, 555, 576; X-(1), 249; XV, 136, 1018.
track scales in freight yards of various railways, IX, 555, 556.
wagon scales in team yard, location of, VI, 581.
(see Track Scales.)

—Separating Yard

what it is and what requirements it must fulfill, II, 42.

—Spacing Tracks

in passenger terminal at Polk Street, Chicago, XI-(2), 1276.
of yard tracks, suggestions regarding, II, 43; III, 259, 260; VI, 578.

—Speed

across scales in hump yards, IX, 586.
of cars in gravity yards, IX, 524.

—Storage

yard, when needed and why, II, 43.

—Switch Engine

service in yards and terminals, how arranged and how records are kept, IV, 350.
transfer and switch engine service in yards and terminals, system of handling and keeping records, IV, 350.

—Throat

at stations, allowable curvature in, XIV, 1092.
method of showing occupation and working capacity of station and throat tracks of Broad Street Station, Philadelphia, XIV, 917.
tracks, working capacity of, XIV, 914.

—Track Scales

(see Scales.)

—Train Movement

graphical critical analysis of by three methods, XIV, 914.

Yards—Continued

—Transfer
freight houses with transfer platforms, X-(1), 259, 261, 262.
stations, conditions to be met, suggestions and plans, IX, 525; X-(1), 254.
switch engine service in yards and terminals, IV, 350.
system at Harlem River, V, 206.

—Water Service
(see Water Service.)

—Weighing Methods
methods followed in carload weighing, IX, 557.
practice on gravity hump, IX, 557.

Z

Zinc
treated ties, their effect on track circuits, XIV, 75, 1046.
(see Creosote; Wood Preservation.)

AUTHOR INDEX

Adams, E. E. (and John D. Isaacs)
Effect of the Physical Characteristics of a Railway upon the Operation of Trains, XI-(2), 1311.
The Economic and Efficient Speed of Freight Trains, XI-(2), 1328.

Allen, C. Frank
The Decision of the Chief Engineer Shall be Final, XVI-(2), 255.

Appleton, Thomas
Coal Handling Stations, III, 192.

Anthony, C. C.
Signal Indications and Aspects, IX, 66.

Bailey, Irving W.
On Effect of the Structure of Wood upon Its Permeability, XVI, 835.

Begien, R. N.
Balanced Grades for Use of Assistant Engines, XII-(1), 330.
Discussion on Time as an Element in Grade Reductions, IX, 785.
Dynamometer Tests, Baltimore & Ohio Railroad, XIV, 599.

Berg, Walter G.
The Distinction between Repairs and Improvements, and a Proposed Classification of Maintenance of Way Expenses, V, 305.

Berry, J. B.
Reduction of Gradient, and Elimination of Distance, Curvature, and Rise and Fall, Union Pacific Railroad, V, 689.

Bissell, F. E.
Organization of the Maintenance of Way Department, II, 247.

Bräuning, C.
Gravel as Ballast, XIII, 267.

Brunner, John
Discussion of Compression Formulas, VII, 208.

Bryan, F. A.
Elevation of Curves, II, 301.

Buel, A. W.

A System of Uniform Live Loads for Railroad Bridges, and a Formula for Shearing Stress in Webs and Spacing of Stiffeners of Plate Girders, VII, 211.

Butterfield, J. T.

Electrical Resistance of Timber as Affected by Treatment with Preservatives, XII-(3), 470.

Camp, W. M.

Curve Elevation, II, 262.

Carter, Frank H.

Selection of Length of Transition Spiral, XII-(1), 439.

Campbell, J. L.

Water Treatment and Results on the El Paso & Southwestern Railway System, IX, 113.

Chamberlain, W. E.

The Passenger and Freight Transfer System at Harlem, New York, V, 206.

Chanute, Octave

Consideration of Methods and Cost of Wood Preservation, II, 104.

Discussion of Paper on Comparative Value of Cross-Ties of Different Materials, VIII, 488.

Precautions to be Observed in Burnettizing Ties, X-(1), 637.

Zinc-Creosote Process for Timber Preservation, III, 116.

Christie, James

Modern Developments in the Production of Open-Hearth Steel, IV, 187.

Churchill, Chas. S.

Deflection, Elongation and Compression of 85-lb. A. S. C. E. Open-Hearth Rails in Drop Tests, XII-(2), 188.

Elevation of Curves, II, 304.

Clausen, L. R.

Some Suggestions as to the Selection or Development of a Basis for a Correct System of Railway Signaling, IX, 63.

Courtenay, W. H.

Experience of the Louisville & Nashville Railroad Company with Creosoted Piles and Timber, X-(1), 632.

Crandall, C. L.
A Review of the Development of Metal Bridge Building in America, XI-(1), 139.

Cushing, W. C.
A Study of Forty Failed Rails, XII-(2), 230.
Comparative Service Tests of 100-lb. Sections, P.S. and A.R.A.-A. on the Pennsylvania Lines, XVI, 319.
Comparative Value of Cross-Ties of Different Materials, VIII, 482.
Development of Hump Yards on the Pennsylvania System, IX, 545.
Experiments to Determine the Necessary Depth of Stone Ballast, XIII, 113.
Experiments with Treated Cross-Ties, Wood Screws and Thiollier Helical Linings, XV, 265.
Investigation of Silvery Oval Spots, Sometimes Called "Transverse or Internal Fissures," in Rail Heads, XIV, 413.
Method of Producing Sound Ingots, XIV, 449, 501.
Protecting and Waterproofing Solid Floor Bridges, Pennsylvania Lines, XII-(1), 530.
Stresses in Track Fastenings, X-(2), 1431, 1454.
Study of Seventeen Good Service Rails, XIII, 573.
The Track Superstructure of German Railways, XI-(2), 1337.
The Question of the Improvement of Rail Design and Specifications, from 1893 to the Present Time, XIII, 853.
The Question of Screw Fastenings to Secure Rails to Ties, X-(2), 1456.

Dawley, W. M.
Drainage of Soft Spots in Old Roadbed, VIII, 541.

Dennis, A. C.
The Basis of Variation for Operating Costs Applicable to the Design of Railway Operation, XI-(1), 685.

Dudley, Dr. P. H.
Ductility and Elongation Tests, XIV, 193.
Ductility of Rails, XII-(2), 548.
Stremmatograph Tests of Track Under Service Conditions, XIV, 563.
The History, Development and Use of Rails by Railroad Companies of the United States from 1830 to Date, XIII, 843.

Eddy, C. L.
Rolling Resistance of Cars over Switches and Frogs, XIV-(2), 279.

Fish, J. C. L.
Extra Top Width for New Fills, XV-(2), 47.

Fosberg, R. P.
Card Index System for the Maintenance of Way Department, III, 369.

Fritch, L. C.
The Storage Battery in Railway Service, XIII, 1181.

Goodrich, Ernest P.
The Supporting Power of Piles, XI-(1), 217.

Green, F. W.
Cost of Stopping and Starting Trains, XVI-(2), 271.

Greiner, J. E.
Rolling Loads on Bridges, XV-(2), 233.
Specifications for the Erection of Railway Bridges, XI-(1), 130.

Guppy, B. W.
On Maintenance of Existing Metal Bridges, VIII, 369.

Hadfield, Sir Robert
On a New Method of Revealing Segregation in Steel Ingots, XIV, 487.

Hatt, W. K.
Note on the Strength of Ties Treated with Crude Oil, XII-(3), 467.
Strength of Reinforced Concrete Beams, V, 620.
The Effect of Change of Moisture Condition on the Strength of Timber, VIII, 417.

Higgins, H. K.
Replacement of Bridges and Allied Structures, IX, 235.

Himes, A. J.
Discussion of Paper on Stresses in Track Fastenings, XIV-(2), 298.
On Classification of Existing Bridges, VIII, 361.
Rail-End Connections for Drawbridges, XVI-(2), 245.
The Elimination of Grade Crossings at Cleveland, Ohio, XV-(2), 103.

Howard, C. P.
Curvature, XI-(1), 678.
Grade Reduction Problems, XV-(2), 3.

Howard, James E.
Strength and Endurance of Steel Rails, IX, 475.

Howson, E. T.
Recent Developments in Track Construction, XVI-(2), 3.

Humphrey, C. J.
Fungi which Live on Structural Timber, XI-(2), 818.

Irwin, A. Chas.
Heavy Locomotive Loadings, XVI-(2), 299.

Isaacs, John D. (and E. E. Adams)
Effect of the Physical Characteristics of a Railway upon the Operation of Trains, XI-(2), 1311.
The Economic and Efficient Speed of Freight Trains, XI-(2), 1328.

Johnson, Thos. H.
Steel Rails, XII, 851.

Karnopp, E. B.
The Arrangement of Loading Tracks at Piers, XI-(1), 250.

Kempfer, William H.
The Air-Seasoning of Timber, XV-(2), 163.

Kendrick, J. W.
Conservation of Cross-Ties by Means of Protection from Mechanical Wear, XI-(1), 581.

Kimball, Geo. H.
The Unification of the Freight Terminals of a Large City, XV-(2), 29.

LaBach, Paul M.
The Computation of Stresses in Angle Bars, XVI-(2), 31.

Lane, H. A.
Baltimore & Ohio Railroad Passenger Stations at Philadelphia and Baltimore, XI-(2), 1270.

Lee, E. H.
Notes on L. C. L. Freight Houses, XV-(2), 363.
Trucking Methods and Costs Through L. C. L. Outbound Freight Houses and Transfer Platforms, XV-(2), 225.

Leffler, B. R.
Concerning Railroad Bridges Movable in a Vertical Plane, XV-(2), 307.

Leslie, R. W.
Uniform Specifications for Cement, V, 645.

Lowell, G. K.
History of an Old Iron Bridge, XIV-(2), 27.

McDonald, Hunter
Discussion on Standard Trestle Plans, VI, 48.

MacFarland, H. B.
Influence of Seams or Laminations in Base of Rails on Rail Failures, XIV, 315; XV, 267.
Report of Test on Gravel Ballast, XIV, 151.
Tests of Longleaf Pine Bridge Timbers, XIV-(2), 31.
Test of Oregon Fir Piling, XVI-(2), 47.

McGill, Anthony
Boiler Feed Waters, VI, 612.

Meade, J. M.
The Use of Screw-Spikes, X-(2), 1549.

Merrill, William H.
The Objects of Tests and Investigations at Underwriters' Laboratories, XII-(1), 613.

Miller, C. H.
River Protection Work, XII-(3), 529.

Moister, F. L.
Heat Treatment of Steel Rails, VI, 180.

Morse, C. A.
Large Capacity Pumping Plant for Region with Limited Flow in Water Stratum, XII-(3), 378.

Mulhern, J. W.
Operation of the Galesburg Yard, Chicago, Burlington & Quincy Railroad, X-(21), 315.

Nichol, J. H.
Oiling Roadbed, I, 93.

North, H. M.
Discussion on Yards and Terminals, IX, 586.

Onderdonk, J. R.
The Effect of Piping, Cavities and Porous Spots in Ingots on the Finished Rail, XIV, 401.

Parkhurst, H. W.
The Requisite Waterway for Railroad Culverts, VIII, 314.

Prior, J. H.
The Design of Railway Bridge Abutments, XIII-(2), 1085.

Poland, W. B.
Comparative Cost of Fast and Slow Freight Traffic, IX, 795.

Porter, H. T.
Track Scales, XIV-(2), 21.

Ray, G. J.
Results with Five Years' Use of Screw-Spikes in Both Construction and Maintenance, XVI-(2), 301.

Rice, C. H.
Historical Notes on Locomotive Water Supply, New York Central & Hudson River Railroad, X-(1), 794.

Rice, S. B.
Gravel Washing Plant of the Richmond, Fredericksburg & Potomac and Washington Southern Railways, XIII, 103.

Richards, Jos. T.
Comparative Wear of Bessemer, Open-Hearth and Nickel Steel Rail, on Pennsylvania Railroad, XIII, 635.
English Track on the Pennsylvania Railroad, XIV-(2), 265.

Riddell, Geo. W.
Tests on Roof Coverings, XII-(1), 617.

Roberts, S. S.
Formulas for Determining Switch Leads, X-(1), 469.

Robinson, A. F.
Open versus Ballast Deck Structures, IX, 253.
Standard Plans for Pile and Timber Trestle Bridges, Atchison, Topeka & Santa Fe Railway System, VI, 43.

Rogers, W. A.
Railroad Concrete Masonry, III, 311.

Rohwer, H.
Discussion on Earth Slides, IX, 398.

Ross, H. H.
Description of "One-Pipe Circulation Method" Trackpans, Lake Shore & Michigan Southern Railway, XII-(3), 373.

Rowe, S. M.
Effect of Treated Tires on Electrical Appliances Used in Block or General Signal Service, IX, 765.

Rudd, A. H.
Signal Indications and Aspects, IX, 58.

Scheibe, R.
The Testing of Rails, XIV, 573.

Schmidt, Edward C.
The Heat Transmission Loss Due to Boiler Scale and its Relation to Scale Thickness, IX, 135.

Schneider, C. C.
Discussion on Two Grades of Steel for Structural Specifications, III, 342.

Schubert (Director)
The Action Under the Tie of a Railroad Track, VII, 105.

Schuerman, W. H.
The Greatest Bending Moment Produced by Cooper's E-40 Loading, XII-(3), 308.

Selby, O. E.
A Study of the Stresses Existing in Track Superstructure and Rational Design Based Thereon, VIII, 52.

Sesser, John C.
Cost of Steam Shovel Work, VIII, 324.

Shurtleff, A. K.
Locomotive Fuel Consumption and the Speed Diagram, XIV-(2), 3.
Relative Values of Coal and Gasoline as Fuel for Railroad Pumping Stations, X-(1), 781.
Time as an Element in Considering Grade Reductions, IX, 775.

Smith, C. E.
Bridges over Navigable Rivers—Some Practical Considerations, XIV-(2), 185.
Comparison of Traffic at Grade Crossings and Information with Reference to Apportionment of Cost of their Elimination, XVI-(2), 151.

Snow, J. P.
Discussion of Scleroscope Tests, XI-(1), 511.
Wharves, Piers and Docks for General Freight Purposes, II, 153.

Stetson, E. E.
A Study of Rail Pressures and Stresses in Track Produced by Different Types of Steam Locomotives when Rounding Various Degree Curves at Different Speeds, X-(2), 1432.

Stevens, F. S.
Turnouts, IX, 424.

Swartz, Albert
The Dearborn (Polk Street) Terminal Station at Chicago—Chicago & Western Indiana Railroad, XI-(2), 1277.

Talbot, A. N.
Report on Experiments on Water Columns at the Hydraulic Laboratory of the University of Illinois, XI-(2), 1182.

Thompson, A. W.
Discussion on Rail Wear, XI-(1), 701.
General Information Concerning the Scleroscope and Its Use on the Baltimore & Ohio Railroad, XI-(1), 494.
Rail Failures Due to Burns and Crystallization Caused by Slipping of Engine Drivers, Baltimore & Ohio Railroad, XI-(1), 552.
The Use of Titanium Rail on the Baltimore & Ohio Railroad, XI-(1), 516.

Tiemann, H. D.
The Microscopical Structure and Physical Condition of Wood as Affects Penetration by Preservatives, X-(1), 638.
The Physical Structure of Wood in Relation to its Penetrability by Preservative Fluids, XI-(2), 781.

Trench, W. I.
Cleaning Stone Ballast by Use of Screens, XIV, 163.

Trimble, Robert
Study of Seventeen Good Service Rails, XIII, 573.
Track Superstructure with Cast-Iron Chairs, XV-(2), 389.

Vaughan, George W.
Ballast, XIII, 290.

von Schrenk, Dr. Hermann
Changes Which Take Place in Coal-Tar Creosote During Exposure, IX, 739. (A. L. Kammerer, E. B. Fulks.)
Report on Experimental Track in Texas, V, 93.
Seasoning Tests of Cross-Ties, V, 79.
The Decay of Timber, II, 115.
The Investigations of the Department of Forestry on Decay of Timber, III, 117.

Wallace, J. H.
Wheeler Process Rail, II, 198.

Webb, Walter Loring
Rail Wear, XI-(1), 695, 707.

Webster, William R.
Comments on Specifications for Steel Rails, II, 194.

Wickhorst, M. H.
A Study of Sixty-Eight Failed Rails, XII-(2), 293.
Abrasion Tests of Rails on Revolving Machine, XIV, 213.
Carbon and Deflection of Rails in Drop Tests, XII-(2), 222.
Comparison of Basic and Acid Open-Hearth Rail and Influence of Reheating Cold Blooms, XV, 241.
Drop Tests of Rails, XII-(2), 529.
Equated Tonnage Rating for Locomotives, Chicago, Burlington & Quincy Railroad, XIII, 1151.
Flow of Rail Head under Wheel Loads, XII-(2), 535.
Formula for Deflection of Rails in Drop Test, XVI, 189.
Influence of Aluminum and Silicon on Bessemer Ingots and Rails, XV, 337.
Influence of Carbon on the Properties of Rails, XVI, 161.
Influence of Finishing Temperature on Open-Hearth Rail, XVI, 349.
Influence on Rail of Amount of Draft in Blooming, XV, 211.
Influence of Rolling Temperature on the Properties of Bessemer Rails, XIII, 797.
Influence of Silicon on Open-Hearth Ingots and Rails, XIV, 507.
Influence of Titanium on Bessemer Ingots and Rails, XIV, 219.
Internal Fissures in New Rail, XVI, 389.
Investigation of a Split Head Rail, XII-(2), 469.
Pipeless Ingots, XIV, 289.
Report of Tests of Open-Hearth Rails, Gary Works, 100-lb. A. R. A.-B, XII-(2), 428.
Review of Rail Investigations, 1910-1914, inclusive, XVI, 411.
Seams in Rails as Developed from Cracks in the Ingot, XV, 315.
Segregation as Influenced by Fire-Clay on Ingot, XII-(2), 494.
Segregation and Other Rail Properties as Influenced by Size of Ingot, XIII, 655.
Strength of Rail Head, XII-(2), 518.
Study of Seventeen Good Service Rails, Discussion, XIII, 573.
Study of a Rail with Internal Fissures, XVI, 195.
Summary of Tests and Conclusions, 1910, XII-(2), 385.
Tests of Bessemer Rails, Illinois Steel Company, South Works, XII-(2), 413.

Wickhorst, M. H.

Tests of Bessemer Rails, Maryland Steel Company, XII-(2), 387.
Tests of Bessemer Rails, Edgar Thomson Works, Carnegie Steel Company, 90-lb. A. R. A.-B., XII-(2), 448.
Tests of Rail Steel Ingots and Derivative Shapes made at Watertown Arsenal, XIII, 753.
Tests of Titanium Bessemer Rails, Lackawanna Steel Company, XII-(2), 399.
Transverse Ductility of Base of Rail, XIV, 303.